PETROLEUM TECHNOLOGY IN ONTARIO DURING THE 1860s

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FOREWORD

For good librarians, financial aid and friends who helped make this thesis possible I give thanks and credit without any of the blame for its shortcomings.

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INTRODUCTION

As a serious academic discipline the history of technology in Canada is in its infancy. The purpose of this thesis is to advance and make a contribution to that study. The role of technology has not been sufficiently considered in interpreting Canadian history but even when this thesis is completed that lack will remain basically unaltered. Although there is a need for the interpretive framework provided by the grand cosmic schemes of scholars such as Lewis Mumford the history of technology in Canada is not yet ready for these. It is a foolish workman who erects the framework where there are no foundations for his grand edifice.

The foundation work, the digging and grubbing about in the dirt, must be done first and this thesis is an attempt to set one stone in solid ground. After it has been joined by others the time will then be ripe to formulate interpretive schemes of strength and value. One must know what happened before presenting hypotheses explaining why something happened and this thesis is an attempt to supply the what happened, the narrative, to some of the technological issues faced in the first

decade of the petroleum industry in Canada. The material presented here might be used for all manner of interpretive and comparative studies but such activities are clearly outside the bounds of this thesis and one should not expect to find them.

The oil industry in Ontario during the 1860s is a particularly apt foundation stone upon which to build an understanding and interpretation of the role of technology in the development of Canada. For over a century petroleum has played an increasingly important role in Canadian economic and industrial development and the way is therefore open for the study of an industry over an extended period ot time. The petroleum industry in Canada has not yet been properly studied and much of what has been written is, with few exceptions, of questionable value. Another reason why the study of the petroleum industry, and particularly its technology, is a worthwhile pursuit is that it is a study of the development of an industry largely unhampered by previous traditions. Before the oil boom there was not a petroleum industry because petroleum was with few exceptions a non-resource. During the 1860s petroleum was transformed into a valuable resource.

The history of the Canadian oil fields during the 1860s is primarily the study of how a county - Lambton - and a country - Canada - responded to the needs of a new industry. The oil industry is a gauge to measure the technological sophistication of Canada and of the ability to step outside the bounds of conventional resource exploitation and simultaneously create and adapt to the needs of a new industry.

Lambton county, located in Western Ontario at the junction of Lake Huron and the St. Clair River, is the centre of the petrochemical industry in Ontario. Almost all of the petroleum refined and used in "Chemical Valley," the part of the county given over to the petrochemical industry, is from outside of Ontario. Few are aware that Lambton county still has producing oil wells.

The oil wells of Lambton county present an historical anomaly. The production of the field has always been small and at present the annual production is not enough to meet the daily refining needs of Chemical Valley. For over one hundred and ten years the wells have appeared to be on their last legs and as a result the financial foundations have been shaky. Larger and more productive North American fields, first in Pennsylvania and then

in other places in the United States and Canada, have always overshadowed the Lambton oil fields. However, in spite of their small role in terms of total North American production at any one period or over the entire history of commercial petroleum exploitation, the Lambton oil fields have played a very important part in the history of petroleum exploitation and technology in Canada. Part of the legacy of this early development is the petrochemical industry in Sarnia and along the St. Clair River.

During the 1860s the petroleum in Canada was transformed from a nuisance into a valuable resource which was the basis of a growing industry. Many problems had to be solved before this transition could take place. The purpose of this thesis is to record and examine some of the technical problems and solutions related to the acquisition, storage, and processing of Canadian oil in Canada during the 1860s.

Prior to the 1860s petroleum had not been the basis of a large industry and there was therefore the need to create quickly - by adaptation or invention - the required technology. The creation did not take place in a vacuum. Knowledge and experience in other fields such as chemistry and the coal tar industry helped to shape the direction of the growing petroleum industry. The geographical nature

of Lambton county was another important formative element in the Canadian oil industry. Although Lambton county was served by railroads and was bounded on two sides by water offering good transportation facilities, the oil fields themselves were rather inaccessible; they were separated from railroad and water routes by virgin forests, swamps, and roads in such poor repair as to be of little use. Lambton county was virtually devoid of industry when the oil boom started. However, the difficulties were not insurmountable and the oil industry grew.

Not all of the questions raised in this thesis have been answered. However, it was not expected that they would be and it is hoped that this thesis will serve as a starting point for further research into petroleum technology. Therefore, it is essential that information be recorded in detail even where questions are not fully resolved. The petroleum technology of the United States and Canada has not been compared but the information provided in the thesis will allow this to be done when more detailed research in the oil technology of the United States and Canada is carried out.

Much has been written about the petroleum industry in the United States but most of it is from the point of view of the economic historian. Much less has been written about the oil industry in Canada but it falls into the same pattern. Hopefully the result of various scholars

looking at the oil industry from different points of view will be a more balanced literature dealing with the pursuit and utilization of petroleum. It is conceivable that one of the by-products of such an approach to history will be a more perceptive awareness of technology and its role. Much of the contemporary writing about the role of technology in history is rather alarmist. Technology is erroneously seen as having a life of its own independent of human judgment and control. Technology is one of the important factors shaping and shaped by history but it has been widely ignored by historians. The result is that technology has been surrounded with an aura of mystery and powers that it does not merit.

CHAPTER I

SURFACE WELLS AND EARLY CANADIAN PETROLEUM EXPLOITATION

In one sense all history is written backwards in that to write it one must go back in time. But some history is more backwards than others in that the historian is searching for and looking mainly at that which he sees as similar to present practice, using as the guide to his selective processes the closeness to which the past anticipates present. Looking at history in this manner, particularly if to this one adds a maligned touch of national or local pride, sends people scurrying after 'firsts'. In the case of the oil industry playing the 'first game' means quibbling over who drilled the first oil well while ignoring some of the more important issues. There is another approach to the petroleum industry, seeing it for what it is: a mining industry. Then the drilling non-drilling dichotomy appears to be less central since it merely expresses two stages in the development of the specialized techniques of a particular mining industry.

The petroleum industry is rarely regarded as a mining industry but this is understandable. Petroleum does not look, act or feel like other minerals and as a

result petroleum technology is unlike other mining technologies. In many respects petroleum resembles water and many elements of water well technology were adapted to petroleum mining. But the differences between water and oil, the differences between oil and other minerals, tended to obscure the similarities and petroleum was regarded as a unique substance. In the initial flush of enthusiastic optimism and boosterism the differences were seized upon and the similarities unwisely pushed into the wings.

As has been the case with many minerals and mineral deposits it is the surface finds, the readily visible, that first attracted attention and were worked, and in this respect petroleum in Canada West and elsewhere resembles other minerals. In Canada West the "surface shows" attracted the attention of and were utilized by the native North American Indians and European settlers.[1]

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1. An unidentified newspaper clipping in the Smith Collection and based on a report of July 19, 1860 refers to an Enniskillen farmer who knew of the existence of oil on his property and had been using it for 25 years. As indicated in the Bibliographic Essay the Smith Collection is unindexed; a copy of the clipping is in my files as "S25-19". Items from the Smith Collection which are unidentifiable will hereafter be referred to as Smith followed by my file reference number, and date if known. The Smith Collection is owned by George Smith of Sarnia and Brights Grove, Ontario.

These shows were of two types: liquid and solid or semi-solid. One reporter aptly described the liquid surface shows as "little oozings of oil from the ground, either with or without a spring of water."[1] If no water were present for the oil to float on small quantities of the oil might attract attention bv its offensive odour, but water made it easier to find since wherever water "stood in little pools" the oil formed a "scum" on top with characteristic rainbow hues.[2] This oil was easily skimmed from the surface of the water.

Not all of the oil that seeped up from the depths found its way into streams or little puddles and it was this oil which gave rise to another and more spectacular

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1. Toronto Globe, Jan. 25, 1861. [Hereinafter referred to as Globe.]

2. Toronto Leader, June 30, 1861. [Hereinafter referred to as Leader.] These scums should not be confused with the oil slicks frequently referred to at present as the result of oil tanker disasters. The latter are far larger and usually of heavy bunker oils. Closer to the modern oil slicks would be the crude and waste oil slicks on Bear and Black Creeks which were constantly commented upon and occasionally on fire. The oil slicks that I am talking about are those found in quiet recesses, perhaps upstream of a dead branch now leading an amphibious life, half on shore and half in the stream, while awaiting its return to the earth that nourished it. They are like the little pools that I played with as a child on hikes to the 'gas bubbles' near Albion Falls, Hamilton.

surface show: the gum beds. Gum beds were formed over the years as crude soaked up through the soil and did not run off into streams. The lighter fractions evaporated leaving a dry gummy asphalt-like or bituminous substance on the surface of the soil and mixed with oil-soaked earth beneath this. "Tarry bitumen"[1] is how it was usually described. In Lambton there were two gum beds which properly deserved the name. One such bed in the first concession of Enniskillen was said to be about 3 acres in area although accounts vary considerably.[2] Pioneering oil men such as Tripp and Williams[3] first worked

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1. T. Sterry Hunt, "Notes on the History of Petroleum or Rock Oil," The Canadian Naturalist and Geologist, VI (August, 1861), 248. [Hereinafter referred to as Hunt, "Notes on Petroleum".]

2. Leader, June 30, 1861.

3. James Miller Williams was perhaps the first major oil promoter in Canada. He was not one of the founders of the International Mining and Manufacturing Company. He appears to have gained control of the company by 1857 and throughout the 1860s was one of the most powerful men in the Canadian petroleum industry.

   The Tripp brothers, Charles N. and Henry, are even more mysterious than Williams. The Tripp brothers became involved in oil exploration and promotion earlier than Williams but unlike Williams were not astute businessmen and appear to have lost everything. The Tripp brothers showed others where money was to be made but did not share in the money.

the gum beds, i.e. easily seen and gathered surface shows. Details of early development are somewhat lacking, but in 1855 The International Mining and Manufacturing Company was awarded an Honourable Mention at the Paris International Exhibition for its asphalt.[1] It might be assumed that this was a finished asphalt produced from the Enniskillen gum beds but a word of caution is necessary. No description of the material as a finished product has been found and since it was part of Logan's Geological Survey Collection it might have been unprocessed as was the 1,450 pound sample that Thomas McIlwraith had analysed in Hamilton for Tripp in 1855.[2] However, it is on good authority that it was in "1857 that Mr. W. M. Williams of Hamilton, with some associates undertook the distillation of this tarry bitumen."[3]

Before Canadians could derive full benefit from

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1. J. C. Taché, <u>Canada at the Universal Exhibition of 1855</u> (Toronto: John Lovell, 1856), p. 372.

2. See Appendix C.

3. Hunt, "Notes on Petroleum," 248. There is a printing error in the article referred to; it should read "J. M." not "W. M." Williams.

their petroleum they had to quit wishing that it was something else. Canada lacked coal. Canadians and many others were acutely aware of this lack and in many respects petroleum was a coal substitute. It was found on the ground or dug from the ground[1] and could be burned as is or heated to produce other products. Williams' earliest work had been with a solid or semi-solid which he treated as a coal. When he found petroleum naturally occuring in its free liquid state there was a period in which he saw the liquid as a rarer and less dependable mode of occurrence and seemed unwilling to rely on it completely.[2] By January, 1859 Williams was obtaining liquid petroleum from dug wells but it was reported that he did not intend to rely "upon that source of supply ... works are in the course of erection for treating the oil earth after a fashion somewhat similar to that in which coal is treated."[3] By

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1. Digging shafts for oil reached its highest state of development in Burmah. See "Petroleum in Burmah," Atlantic Monthly, XXII (October, 1868), 404-413.

2. For an account of a well dug by Williams perhaps as early as 1857 see the Globe, May 4, 1863.

3. London Free Press, Jan. 27, 1859. [Hereinafter referred to as Free Press.]

August of 1859 at the very latest Williams was concentrating his efforts on pumping liquid petroleum, an approach which he had probably been trying for some time.[1] An August 1858 report mentions that "a hole dug 8 or 10 feet in width and about the same depth will collect from 200 to 250 gallons a day." This oil, according to the same report is "barrelled up and sent to Hamilton to be prepared there."[2]

Pinning one's hopes on wells to obtain liquid petroleum directly from the earth rather than distilling it from the earth represents a change in attitude which was to have important technological consequences.[3] With the transition from the search for petroleum bearing earth to liquid petroleum there is a change of technique. One ceases digging up and carting away the earth as in open pit mining and begins to sink shafts or wells.

It is not clear how the transition took place but there are several possibilities. Williams has left

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1. Free Press, Aug. 5, 1859. See also W. P. Fisher, "Letter to the Editor" Journal of the Board of Arts and Manufactures for Upper Canada, I (Feb. 1861) 46. [Hereinafter referred to as Fisher, "Letter".]

2. Free Press, Aug. 26, 1858.

3. It might be added that those pursuing the 'first driller' have not looked at this aspect of the search for petroleum.

no direct evidence but the newspapers were interested in the work of Williams and other oilmen. It is possible that in digging a hole for petroleum Williams was only following a part of one of the traditional methods of collecting oil in Canada West. "A large hole would be scooped out of the soil, which in the course of a few hours would be full of fluid."[1] One account mentions Williams digging soil for retorting and that "in digging up the soil for this purpose he found that the oil ran into the sides of the hole. This led him to further digging, and now after several attempts, all more or less successful, he has a well in full operation which supplies as

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1. Free Press, Jan. 27, 1859. The description continues: "at the surface of which floated an oily substance, a blanket or woolen cloth had then to be thrown on to the surface of the fluid, and the oil being uppermost, absorbed it. The oil was then wrung out from the blanket into a vessel, and the operation repeated until a sufficient quantity had been obtained."

much oil as he can want."[1] If such was Williams' inspiration then he modified it as surface wells were cribbed and puddled so as not to allow oil to seep in through the sides but only through the bottom. Cribbing and puddling also prevented cave-ins.

Next is the accident or serendipity theory: the classical oil find story -- looking for water and finding oil. The London Free Press reported one such incident: "An important discovery has just been made in the township of Enniskillen. A short time since, a party, in digging a well at the edge of a bed of Bitumen, struck upon a vein of oil, which combining with it the earth, forms the Bitumen."[2] The story is very plausible because oil and water wells were constructed similarly[3] and it

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1. Leader, June 30, 1860. Harkness believes that the "only reason J. M. Williams didn't drill a well at Oil Springs in 1855 or 1857 was that it was so much easier to bring a shovel and an axe through the swamps of Enniskillen than to haul a boiler and engine over the bottomless road." This is stated in Col. Bruce Harkness, Early Historical Record of First Oil Well in America: The Williams Well, Oil Springs, (n.p., n.d.). Although no publication data is given it is known that it was published in 1958. The argument simply does not hold up. For the little equipment that Williams would have needed the roads, not yet destroyed by legions of oil men, would have been more than adequate.

2. Free Press, Aug. 5, 1859.

3. The construction of water wells is dealt with in Charles Spurgeon Buck, The Origins and Character of the Early Architecture and Practical Arts of Ontario to 1850 (unpublished M.A. thesis, University of Western Ontario, 1930).

was not yet clear that digging a well was the best to get oil.

The third theory or reason why wells were dug is less tradition or serendipity than analytical sense. Williams or one of his employees may have felt that oil oozed out of the bottom and sides of a hole because the act of digging a hole created a pressure difference to which the oil responded. Digging down was a means of decreasing the pressure on the oil from above thereby allowing the oil to escape. As one reporter put it, they found "the oil coming easier to the surface when the weight of the earth over it is not so great."[1]

There is a fourth alternative or theory. Esoteric as it is petroleum is a mineral and the conventional way to mine minerals is to dig a hole or shaft in the ground. Shafts for retrieving liquids are called wells.

Although one may not be sure why the wells were dug, other than to get more oil, it is known how they were dug, constructed, and worked. The earliest contemporary description of what might be a surface well dates from August 1858. It is rather vague: "a hole dug 8 or 10

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1. Globe, Jan. 25, 1861.

feet in width and about the same depth."[1] The well might have been straight sided and/or cribbed or just a large scoop or trench out of the ground into which oil seeped from sides and bottom. There is an earlier but questionable reference to a well in Bothwell on the banks of the Thames.

> "Mr. Tripp, A Canadian, sent by Mr. Williams of London" dug a "well to a depth of some 27 feet without meeting with any special indications of oil ... the next morning, when going to the well to resume digging, he found it full of oil and water. Afterwards an attempt was made to drive an iron pipe down in the well, but the pipe had been driven a considerable distance, it broke and the well was abandoned. This well was commenced some six years ago. At present the water in the cribbing is covered with oil." [2]

This well was cribbed but one cannot be sure as to the date of 1857 although it probably is correct.

Fortunately there are a number of wells for which more certain data is available. However, I do not propose to use this data to chronicle or list wells and their vital statistics but rather to build a composite picture with ranges of variation and exceptions indicated.

Surface wells were dug by hand: there is not any evidence to even suggest the contrary. There seems to

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1. Free Press, Aug. 26, 1858. The length is not mentioned; the hole was probably square or close to it.

2. Globe, May 4, 1863.

be no standard surface size or configuration although they were generally rectangular or square with the round being rare in the early 1860s but less so by the mid 1860s.[1] In their issue of September 6, 1861 the Globe gave the vital statistics for fifty Enniskillen wells; the data is incomplete because there were about 400 wells; but "as they resemble on another very closely in almost every particular, it is unnecessary to give a description of each." Information on depth is very complete but is extremely wanting for length and width. Surface dimensions were given for only four wells, two square (six feet square and five feet square) one rectangular (ten feet by eight feet) and one round (seven in diameter).[2] It is therefore necessary to look elsewhere for surface dimensions but this is to be done after using the data regarding depth.

The depth of a surface well or the surface portion of a drilled, i.e. rock well, is the depth at which the rock is reached or oil is given in such quantities as

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1. Globe, Sept. 2, 1861.

2. Globe, Sept. 6, 1861.

to make further digging unnecessary or impossible.[1] In the Globe report the depth of surface wells varied from 40 to 60 feet with the surface portion of drilled wells varying from 42 to 70 feet.[2] The arithmetical average depth for these is 49.0 and 49.6 feet respectively.[3] There are other dimensioned descriptions of surface wells. Williams' well was thirty feet deep before August 5, 1859.[4] Another early well, the Donaldson, "was sunk ... by Robert Dobbyn, and is eight feet wide, twelve feet in length, and thirty-six feet deep."[5] In June of 1860 a Williams' well, described as his "principal well", was "about fifty deep and about eight feet square;

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1. Undoubtedly some digging was halted by gas but this seems to have been viewed as little more than a temporary setback. The Globe, Sept. 2, 1861, noted that "there are two classes of wells, the rock and surface. In the former, the rock is bored through until the oil is reached. In the latter, the well is merely sunk in the earth until the oil appears and renders further digging unnecessary."

2. The figure 70 might be regarded with some suspicion. The two next deepest are 68 and 60 feet.

3. The data is based on 21 surface wells and the surface portion of 26 bored wells, i.e. rock wells.

4. Free Press, Aug. 5, 1859.

5. Smith, S25-19, July 19, 1860.

it has perpetually thirty-eight feet of oil."[1] In early 1861 Williams was credited with having five wells "about 40 feet deep",[2] a statement in apparent agreement with the anonymous Clevelander's description of "large holes in the ground generally about 10 feet square, to the depth of 30 to 50 feet."[3] Another well is simply described as being 53 feet deep[4] with another description adding that "the wells are not circular, but for the most part nearly square." Others were described as "not 60 feet deep",[5] "70 feet"[6] and dug and cribbed with boards to

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1. Leader, June 30, 1860.

2. Based on Charles Robb, "On the Petroleum Springs of Western Canada," The Canadian Journal of Industry, Science, and Art, XXXIV (July, 1861), 317 and the report of the same lecture which was given in the Globe, Sept. 6, 1861 describes one of Williams' wells as being 46 feet to the rock and 100 feet in the rock and having been in operation for 2 years; this is not to say that it was bored in the rock 2 years ago but was probably a deepened surface well of which Lambton was to have many.

3. Globe, Feb. 15, 1861.

4. Smith, S25-48, June 22, 1861.

5. Sarnia Observer, Oct. 6, 1865. [Hereinafter referred to as Observer.]

6. Observer, March 1, 1866.

40 feet.[1] The average depth of surface wells appears to be in the range of 50 feet.[2]

As regards cross-sectional area the task is more difficult as there is less information and it is rather imprecise. There are a few dimensions to be added to those previously listed. For round wells four and one half to five feet in diameter was common according to one source[3] while another speaks of a well six to eight feet in diameter and overflowing.[4] The same source speaks of a well eight feet by twelve feet overflowing[5] while another who also speaks of overflowing wells regards five feet square as common.[6] Giving equal weight to all

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1. The Canadian News, March 27, 1861, p. 102.

2. A depth of fifty feet is ten feet more than the average depth given by the Carbon Oil Co. in a letter of Jan. 7, 1861. See Fisher, "Letter". The discrepancy should not be cause for concern. The sample reflects the state of affairs at least six months after the Carbon Oil Co. figures were taken, a period during which surface wells were going deeper. A figure much over 50 feet would put the wells into bedrock in most parts of Enniskillen.

3. Globe, March 12, 1862.

4. Globe, July 29, 1860.

5. Smith, S25-18, July 19, 1860.

6. Globe, Aug. 30, 1861.

of these references the average cross-sectional area is 52 square feet. Average storage capacity of a surface well would then be somewhere in the range of 26,000 cubic feet or 1350 gallons, less than 35 barrels.[1]

Digging and constructing a surface well was a relatively easy job apart from the manual labour involved. The job encompasses three separate processes: digging, cribbing, and puddling. Digging was accomplised by pick and shovel: suitable tools for "stiff clay intermixed with gravel."[2] It is clear from the report of a "sad accident at the Oil Springs" in which four lives were lost that in digging surface wells powder was used to blast the rocks impeding digging.[3]

The cribbing was to stop the walls from caving in while the cribbing and puddling together would, in theory, prevent any water or oil from leaving or entering

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1. Calculations were based on an Imperial gallon of 277.274 cubic inches which is the legal British definition in force between 1824 and 1878. See Robert E. Hardwicke, The Oilman's Barrel (Norman: University of Oklahoma Press, 1958), p. 16. All calculations are based on a barrel of 40 Imperial gallons.

2. Smith, S25-19, July 19, 1860.

3. Canadian News, May 19, 1864, p. 310. The fatal blast was not caused by the powder but by gas in the well which exploded when one of the men in the well lit his pipe.

the well through the walls.[1] In digging a well "as fast as it was sunk" it "was cribbed with logs put together inside the well, in the same way that houses are usually built."[2] The material for the cribbing would be any of "timber, logs, and boards."[3] The finished form in which the raw material, wood, was used depended upon other technological factors: planks or boards if a saw mill were nearby, rough logs if not. Whether or not the well was square or circular was not dependent solely upon the aesthetic sense of the well digger.

> The way in which the well is sunk is this, a hole from 4½ to 5 feet in diameter is dug to the rock in the ordinary way, the sides being cribbed up with timber to prevent them falling in. Hitherto square wells have been principally made, and by taking pieces of timber, and dove-tailing the ends, the well sinkers have been able to make their cribs at little cost, and with very rough tools. But the erection of a saw mill near the creek, has made the lumber cheap, and cribs are now being made in the shape of large tubs -- but without either top or bottom -- which being let down in the wells as the sinking progresses, effectually protects the sides.[4]

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1. Globe, Aug. 30, 1861.

2. Smith, S25-19, July 19, 1860.

3. Globe, Feb. 15, 1861.

4. Globe, Mar. 12, 1862.

It should be added that iron and a blacksmith were needed to make the hoops surrounding the tub-like cribbing.

Between the cribbing and the walls of the excavation clay was puddled "so as to keep out the surface water"[1] and to keep the oil in. This was done using the impervious Erie Blue Clay, "Enniskillen Blue", which when in a rather viscous semi-fluid state would be compacted.[2]

The theory and construction of surface wells is rather simple and straightforward and so was the operation. Generally the wells performed very satisfactorily and disasters seem to have been quite rare. On occasion surface wells would "cave in"; two of the wells in the fifty mentioned in the Globe of September 6, 1861 were listed as having caved.[3] Although cave-ins were rare occurrences there is one account of such which deserves quotation as a source not only of an amusing incident but also of the attitudes of various oil men. The incident started when a George R. Haven "sunk to

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1. Globe, Aug. 30, 1861. By surface water is meant not only the water on the surface of the ground but also that in the soil, clay and gravel, i.e. the drift, above bedrock.

2. I have been unable to find any references to the tools used in compacting.

3. Globe, Sept. 6, 1861.

the rock" i.e. dug a surface well to the rock.

> The oil broke in suddenly, and in a very short time filled the well to overflowing. As speedily as might be, Mr. Haven made a tank capable of holding 750 barrels, and has taken from the well over 600 barrels. Envying his success, an enterprising Yankee who is called "Colonel" by his friends and acquaintances, sunk a well within a few yards of Haven's; but although he went down quite as deep, he did not lessen the flow of oil to his neighbor's well. Indeed he got but slight symptoms of the much desired fluid. Greatly to the delight of sundry observers, the men at work for the "Colonel", took from the well a large boulder, the effect of which was to cause the cribbing to give way for want of proper support, and the hole "caved in". He followed suit, "caved in himself", and sold out to a Californian named O'Grady for about a third of the sum the well had cost him. None were better pleased than the Americans at his ill success. The considered his practice too sharp.[1]

Ideally the oil came up through the rock or clay and gravel, gradually filling the surface well from the bottom, not through the sides. Wells could come in quietly but the preferred mode for the benefit of reporters and visitors was to have it burst in suddenly when the workers were still a few feet from the rock. This way, "with much noise and uproar of gas", it could burst in "from the loose gravelly substance overlying the rock" and perhaps even "run over and waste hundreds of barrels"[2]

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1. Globe, Sept. 2, 1861.

2. Globe, Aug. 30, 1861.

of oil. Generally surface wells came in quietly, seeping up from the bottom as they should with lunch time and the night hours being the preferred times.

Not all surface wells came in as expected. On one occasion a surface well had been sunk to thirty-six feet with plans to go further.

> as the indications of oil were not, at that depth, sufficiently encouraging, but, as the men were proceeding with their operations, they were startled by a loud rumbling noise like distant thunder, apparently in the ground, within a few inches of the shaft, and it increased to such an extent as to cause a suspension of the work for part of a day. Subsequently a loud report was heard, and upon examining the well Dobbyn found that the gas and oil had forced a passage through a crevice in the cribbing about ten feet from the bottom, and through this opening of about five inches in length, by one inch, at least, in width; the oil was flowing into the well.1

Such a disaster was really no disaster at all and would have been welcomed by many.

The digging of a surface well necessitated the expenditure of considerable labour and therefore of money but no one seemed to complain about this. Using the average depth of 50 feet a surface well in Enniskillen could at $3.00 per foot be dug and finished for $150.00. Five years later surface wells were dug for "an expenditure

1. Smith, S25-29, July 19, 1860. This well had clearly not yet been puddled and might not have been cribbed completely at the time of the incident referred to.

of only \$100 to \$150."[1] While none of the oil men or commentators seemed to be concerned about the cost of digging a surface well they did worry when the well stopped giving oil or gave an oil-water combination too heavily weighted towards water; there were ways around these problems. The latter problem is to be considered first.

The surface well was conductor, storage area, and, in one sense, processing area. The oil came up through the well and was held there until removed naturally or artificially. The oil and water could be separated in the well and removed separately at will. Should the well relieve itself of its oil by overflowing then the main problem was that of slowing the flow or finding containers for the oil. When this happened there was no means of control and it is fortunate that in most surface wells the oil level did not rise to the top of the well and pumping, a controlled process, was necessary in order to remove the oil from the well. The details of the pumping operation depended on factors such as the depth of the well and the oil

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1. Canadian News, Sept. 27, 1866, p. 194. By 1866 surface wells were far from the rule but the fact that they were being made at the time serves to emphasize their relative cheapness for this was a time in which the article mentioned in this note claimed that "owing to the cheapness of oil" many who owned wells were "luxuriating" in a "prolonged holiday" and that those wishing wells did not want to invest much capital. Market conditions were so bad that many were not working their wells and the optimists sinking wells were doing so as cheaply as possible.

in the well, the relative proportions of oil and water and their rates of entry, as well as the equipment available and whether or not one could afford to use it.

Any one who has worked with pumps will realize that the depth from which the liquid is to be pumped will often determine the type of pump to be used. The oil men of Enniskillen were no exception.

> The kind of pumps used vary according to the depth of the well. Where the oil is near the surface any sort of a pump will do. When more than 33 1/3 feet, force pumps, or lifting pumps have to be employed.1

Curiously I have been unable to find any descriptions of the actual pump mechanisms and will therefore give only a brief description of what the equipment was probably like. For shallow wells be they water or oil so long as less than about thirty feet the so-called common pump would be adequate. This is merely a suction pump and is similar in principle and in construction to the force pump to be described with only one basic change viz. that the valves in the common pump are near the surface level rather than deep in the well. Deeper wells, whether surface or rock, require a force or lifting pump the principle of which may be discussed without a detailed description of the pumps used in the oil regions of Canada West in the 1860s. No

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1. Globe, Sept. 2, 1861.

matter what the design there are three essential parts: pump barrel, foot valve, and head valve. See Figure one. The barrel is that into which the valves fit. The fit must be tight enough to prevent leakage but loose enough to allow motion of the head valve without undue strain and friction lest the cups rub and wear excessively and consequently leak or cease operating completely. In the oil fields the barrel might, in a rock well, be the well casing itself, if sufficiently smooth, although a more satisfactory arrangement would be if as Greene suggests the "last section of pipe casing ... be of heavy drawn brass tubing to make a proper barrel."[1] At the lower end of the pump barrel is the foot valve, the body of which remains stationary and must have a water and oil tight fit into the pump barrel. The head or upper valve also fits in the pump barrel but is movable, being set in motion by the pump rods or cable. Figure one shows ball valves but flap or clack valves would work. The cups (see diagram) are made of leather, the expansion due to oil and water wetting helping to ensure a good seal.

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1. Arthur M. Greene, Jr., Pumping Machinery: A Treatise on the History, Design, Construction and Operation of Various Forms of Pumps (2nd ed.; New York: John Wiley & Sons, 1919), p. 155.

The operation is very simple as is the equipment itself. On the upstroke the ball in the foot valve will be raised because a partial vacuum will be created between the foot valve and the upward moving head valve unit. The greater pressure of the oil and/or water below the ball of the foot valve causes the ball in the foot valve to rise which in turn allows the oil and/or water to flow upwards into the chamber between the two valve assemblies. On the down stroke the ball of the foot valve will be forced down preventing downward egress of oil and/or water while at the same time the downward movement of the head valve with resultant increase in chamber pressure will cause the ball in the head valve to rise with the result that the liquids will be forced up through the head valve. With the termination of the downstroke and the commencement of the upstroke the ball of the head valve will be drawn down and the ball of the foot valve up; the entire sequence just described would then be repeated. It should be evident that were the bottom (foot) valve to remain open at all times the pump would not work: this happened and there was a patented device designed to overcome the problem. It was claimed in a letter of Aug. 20, 1866 accompanying the patent application that "it has been tried and

found good."[1]

> The pump used is the common or sucking pump: and in most wells the pressure of the gas in the wells upon the valves overcomes their might and thus keeps them open -- when not raised by the pump thus preventing the working of the pump and the pressure of the spring upon the valve is required to over-come the pressure of the gas so that the valve shall be open only when raised by the pump ... the strength of the spring can be proportioned to the pressure of the gas in different wells .... It consists in the application of the spring power upon the valve for the purpose of keeping the valve closed except when raised and opened by the pump.2

The above was simply a sprial spring placed in the opening marked "A" in Figure one. It is not known how well or how widely the invention was used. After the patent had been issued there are no more complaints of gas forcing pumping to come to a halt. On November 9, 1865 the Canadian News announced that in a few days the Campbell well with the gas valve arrangement for pumping will in a few days astonish the most imperturable of oil men by its yield"[3] but it is not known if this referred to

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1. Canada Patent Office, Ottawa. Unpublished letter of Aug. 20, 1866, from Harper and Ebbels, Solicitors, Petrolia, to Board of Agriculture.

2. Canada Patent number 2133, John Henry Eakins, of the Township of Enniskillen, in the County of Lambton, for "A new and useful improvement in the VALVES used in pumping oil wells." Ottawa, 30th October, 1866.

3. Canadian News, Nov. 9, 1865, p. 292.

Eakins' invention. Nor is it known if the lack of complaints indicate that the problem was solved as there were only three complaints about the ravages of gas in the sources consulted.[1]

Very often there would be two pumps per surface well because a well giving oil without water was a rare occurrence indeed. Where two pumps were used it was because the well was being used as the site for oil and water separation. "Two pumps are employed. The oil naturally rises to the top of the water in the well. By means of a force pump the water is taken from underneath the oil; and by means of a common lifting pump the oil is taken from the top of the water and deposited in a large tank close by."[2] Sometimes both pumps would of necessity be force pumps as in one of the Williams' wells which had "in it perpetually thirty-eight feet of oil. This well

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1. Canadian News, May 10, 1862, p. 310.
Canadian News, Nov. 9, 1865, p. 311. This article is from the Bothwell Reporter, the editor of which was particularly perturbed. "We are still labouring under the effects of mismanagement .... For instance, Pope's or McRoberts', which was to have commenced pumping some weeks ago, is doing little or nothing owing to the gas, which keeps the valve of the pump continually raised. Now as we know that pumps can be got which would obviate this difficulty, it is a marvel to us that one of those is not produced at once."
Our third complaint concerns a well on Manitoulin Island and is found in Canadian News, Jan. 11, 1866, p. 22.

2. Globe, Sept. 12, 1861.

is worked by two pumps, one of which reaches to the bottom of the well to draw off the water which oozes in from the sides, the other reaches within two feet from the bottom, and is used for the purpose of pumping the oil into a still on the ground in which it receives its first refining process."[1] Other wells contained "a good deal of water" as was the case with a 50 foot surface well in which the oil was sufficiently close to the top as to be "easily pumped out by a small hand pump" with the force being used to keep the water level down.[2] Controlling the water was important and became increasingly important as the proportion of water rose making it "necessary to use steam pumps to drain the wells."[3]

Steam as a means of removing oil from wells has, with the exception of one source, always meant using steam as a source of motive power for mechanical pumps. There was however one patent granted in Canada during the 1860s to use steam in a different manner. The patent was granted to William Parson Junior for his "Oil Ejector". Steam was forced under pressure through a pipe to the bottom of the well where the steam is to come into contact

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1. Leader, June 30, 1860.

2. Globe, Sept. 6, 1861.

3. Charles Robb, "On the Petroleum Springs of Western Canada," The Canadian Journal of Industry, Science, and Art, XXXIV (July, 1861, 316. [Hereinafter referred to as Robb, "Petroleum Springs".

with the oil and "the whole mass of the oil is violently agitated and broken up into infinitessimally (sic.) small portions, destroying its specific gravity or the hydrostatic pressure of the column ...." Parson's method was to have the effect of "rendering the particles of oil and water for the time very buoyant" and they would be then forced to rise. The patent could also be operated using air power rather than steam. Parson claimed that his

> apparatus does away with the use of pumps to raise the oil, the heavy labour, the continual breakages, the expenses for repairs, and the delays incident thereto; and another advantage which I believe this process possesses, is, the increased temperature of the well by the use of steam, which expands the gases and melts the paraffin out of the crevices of the rocks, obviating the difficulty heretofore experienced by the closing up of the bottom of the well by the paraffine ....[1]

A somewhat similar proposal only this one using water was patented by Otto Rotton of Kingston. The drill hole was to be packed tightly so as to be air and gas tight and only two pipes were to be extended. The longer of the two was to have water under pressure forced through it thereby causing the lighter oil to rise up the shorter pipe which would be raised and lowered so as to keep it in the oil and not in the water.[2]

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1. Canada Patent Number 1765.

2. Canada Patent Number 1947.

I simply do not know if either of the patents discussed above were ever put into use in the oil fields. Rotton did like patenting ideas related to the oil industry although on his patent applications he listed himself as Doctor of Medicine and I have been unable to link him with any oil companies. Parson, on the other hand was of the family owning the largest refinery in Toronto but I strongly suspect that his mode of recovering oil would have produced a crude petroleum and water emulsion that might have been difficult to deal with.

Difficulty in getting oil instead of oil and water was a general characteristic of Enniskillen and Bothwell, the severity varying from well to well. It is doubtful if any wells gave oil with no water for anything but the first shows. Throughout the oil regions of Canada West oil and water were mixed with water frequently predominating. The Kelly Wells, notorious for the difficulty of working them, are simply reported as having "such quantities of water as to render the wells exceedingly difficult in working."[1] The two Williams' wells from which 100,000 gallons had been drawn in eighteen months

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1. Robb, "Petroleum Springs", p. 318.

by common hand pumps gave more water than oil and were therefore being converted to steam pumping to see if this would improve the situation.[1] The same problem existed in rock wells and throughout the 1860s there are references to the fact that the water cannot be kept down[2] or that the only way to keep it down is to adopt bigger pumps and engines.[3]

If the water in surface wells was not pumped the oil would either cease to flow or overflow. In wells such as that of Williams' in which equilibrium was reached with approximately 38 feet of liquid in the well failure to remove the water would mean an ever-increasing proportion of water leaving less room for oil. In some wells if a pump did not keep the water level down then it would rise to such a height as to drive the "oil entirely out of the well",[4] an unfortunate position as much of this overflowing oil would be lost.

In the examples discussed to this point the oil and water have been separated, at least to some extent, in

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1. Fisher, "Letter", p. 46.

2. Canadian News, Dec. 22, 1864, p. 388.

3. Canadian News, Aug. 31, 1865, p. 134.

4. Globe, Jan. 25, 1861.

the well but such, although common practice with surface wells, was not without exception. One well owner did his separating above ground. "Oil and water are pumped out together into a circular tank. The oil is then run off into a tank sunk into the ground."[1] At another well there were "large square wooden tanks, provided with a partition, so that as the liquid rises in one compartment to the level of the partition, the lighter oil flows over and is received free from water in the second compartment."[2]

The proposals of Rotton and Parson were rather complex but were not intended primarily for surface wells. As was the case with digging surface wells the methods of pumping them were rather simple. In spite of its simplicity pumping surface wells was an essential and sometimes troublesome operation. As deeper wells were drilled the problems of drilling and driving pumps increased and the solutions to these problems became more varied.

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1. Globe, Sept. 6, 1861.

2. "The Oil Wells of Enniskillen," Journal of the Board of Arts and Manufactures for Upper Canada, I (June, 1861), 145.

CHAPTER II

PUMPING, DRILLING AND PREPARING OIL WELLS

Great variety in techniques was one of the characteristics of the Lambton County oil industry in the 1860s. One of the major reasons for the great variety is that the oilmen had to learn and to develop the best techniques for the inudstry as a whole and the area in particular. Scarcity of capital, the remoteness of the oil-fields and variations in geological structure all conspired to increase rather than decrease variety and the need for innovations. The techniques of drilling and driving pumps give a good example of the variety found in the Lambton oil-fields. The techniques were crude but effective and as such represent excellent responses to conditions at the time.

Wells were pumped by hand, horse, spring pole, and steam. Throughout the period under consideration none of these methods were entirely superseded although very quickly the horse and steam power came to predominate.

Hand pumping was apparently the first to be used, a method capable of considerable production. Early in 1861 the hand pumps of two wells were replaced by steam

pumps. The pumps and the pumpers deserved a rest after having produced 100,000 gallons, i.e. 2,500 barrels in eighteen months.[1] The hand pump as second best is also seen in a lecture given by William Dentors, lecturer of geology from Detroit. Dentors believed that with steam the wells giving four to five barrels per day by hand would increase production tenfold. In the same lecture he mentioned one well with a "wooden pump" producing at the rate of twenty barrels per day.[2] However, it should be noted that Dentors was referring to the Underhill well, a well that had been overflowing and would have produced a few barrels even without a pump.

The spring pole method of pumping was a development from the spring pole method of drilling or vice-versa; the spring pole is discussed elsewhere. Spring pole pumping as with spring pole drilling had a rather short-lived peak of popularity but did not completely die out. One finds occasional references to wells such as that of "Mr. Mitchell from Paris" who had a surface

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1. The same information is to be found in Smith, S25-42, March, 1861, and Fisher, "Letter", p. 46.

2. Free Press, March 8, 1861.

well and was "pumping it with spring pole power, 10 barrels at 70 feet."[1] This was in 1866.

Hand and spring pole pumping may be seen as temporary or second best measures utilized when nothing else could be used either because of financial considerations or lack of material at any price. Such was not the case with horse and steam power. The use of horsepower presents several curious and rather difficult problems. I have not found any description or pictures of a horsepower rig known to be used for pumping oil wells[2] nor is there sufficient data to draw a clear picture of their popularity and use.

The <u>Globe</u> report of September 6, 1861, potentially a source of good information, is extremely disappointing with respect to horsepower pumping rigs. One well is listed as having a hand pump and a force pump with another having a six horsepower steam engine; for the others no information is given or it is of the "yielding", "pumping", i.e. vague, variety.[3] Another report of the same year is

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1. <u>Observer</u>, Mar. 1, 1866.

2. There was one patent issued in Canada during the 1860s that is relevant to the problem. The patentee was Charles Lee Merrill of London who on July 10, 1868 was granted Canada Patent Number 2668 for "A new and useful Machine for boring wells, to be called or known as 'Merrill's Horse-Power Rock and Earth Drill.'" It is a conventional horse-power rig modified so as to cause a cable attached to a string of tools to be raised and then allowed to fall freely.

3. <u>Globe</u>, Sept. 6, 1861.

more helpful. "Pumping is mainly done with one horse treading machines, 4 steam engines are employed and some managed by hand."[1] The County of Lambton Gazetteer and General Business Directory, for 1864-65, credits Oil Springs with having 300 oil wells "some of which are pumped by steam, the rest by horsepower."[2] Again there is the impression that horsepower is the main means of pumping in the early 1860s, but there are no descriptions of the rigs. Paradoxical as it may seem, it is probable that there is no description because horsepower units were so common for pumping oil, water and for other applications that they did not merit newspaper coverage. The oil would have been pumped by the then common geared rigs around which the horse walked endlessly, the monotony broken only by the need to step over the shaft each revolution.

Although hand, spring pole, and horsepower pumping played roles of varying degrees of importance it was

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1. Observer, Aug. 9, 1861.

2. R. R. Sutherland, A. R. Sutherland, and John Sutherland, County of Lambton Gazetteer, and General Business Directory, for 1864-65 (Ingersoll, C. W.: Sutherland Brothers, 1864), p. 100. [Hereinafter referred to as Lambton Gazetteer: 1864-65].

steam power that was most important during the period under consideration. One of the biggest problems presented by steam engines and a major obstacle to their introduction was the difficulty of getting them from harbour or railroad station to well site. One answer was winter transportation when the mud was frozen and covered with snow. During the winter of 1860-61 steam engines in small numbers were sledded into the oil field. Although it is not known how many were brought in it was not enough. Again the evidence is often contradictory and always incomplete and inadequate. In January, 1861, the Carbon Oil Co. of J. M. Williams was going to try steam pumping for two of their wells.[1] As early as January 1861 the Globe stated that "in many of the wells ... a steam pump has been necessary to keep the water from driving the oil entirely out of the well."[2] But it is not known how many engines were doing the work and for how many wells. An engine could pump a well and then be moved because continuous pumping was not needed in many instances. Steam engines were far from the rule and in March a William Dentors, lecturer in

1. Fisher, "Letter", p. 46.

2. Globe, Jan. 25, 1861.

geology, Detroit, was speaking about three of the major wells in Lambton and recommending that at Kelly's and Adam's wells "proper appliances of pumps and steam engines" be instituted. At Underhill's well he found a man "greasy as a tallow ketch" drawing up oil with a wooden pump.[1] The following month it was reported that "there were two steam engines at work in the diggings, pumping out the oil; they do a good business."[2] It seems doubtful that there were only two engines. It is possible that there were other steam engines for other purposes and that each engine pumped many wells by moving from well to well.

By May of 1861 steam engines brought in during the winter "were being used extensively to pump up the oil."[3] In June, 1861, a report speaks of "some wells worked by steam engines"[4] with no hint given as to how

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1. Free Press, March 8, 1861. Kelly's, Adam's and Underhill's wells were amongst the biggest operations in Lambton at the time but not as big as Williams'.

2. Free Press, April 6, 1861.

3. Observer, May 31, 1861.

4. Globe, Aug. 30, 1861.

many some is. At the Wyoming station there were "steam engines from the Brantford and Buffalo shops."[1] When the Globe published two important articles[2] giving details, albeit incomplete, about a number of wells, surface and rock, the total number of steam engines referred to for pumping was four with three for drilling and two on the way for drilling. Steam engines were also necessary for refineries but not necessarily for distilleries, a distinction which many reporters failed to draw. However incomplete the data may seem, it is clear that by early 1861 steam was accepted as the preferred power source and one whose use was to increase. The situation was aptly described in 1865, although the description would probably also apply two or three years earlier, "no one thinks of touching rock below without a steam engine."[3]

In studying the development of wells to this point the well has been viewed primarily as a conductor, that is as a means of getting to the oil or getting it to

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1. Free Press, June 25, 1861.

2. Globe, Sept. 6, 1861. Globe, Sept. 12, 1861.

3. Canadian News, Aug. 24, 1865, p. 119.

come closer to the surface. Secondarily the well has been seen as a means of storing oil and separating it from water. In doing this it has been necessary to examine some of the problems faced by the constructer of surface wells, it is inaccurate to call him a driller, and how these were met. There are two problems that have not yet been looked at, namely what to do when the flow is so small as to be financially unremunerative or when it stops altogether.

The question of what to do when the well ceases to be unremunerative is exceedingly complex involving the erratic price fluctuations of oil as well as the problem of lowering unit production costs in order that one not "be taken under" by price cuts. Many well owners simply stored and/or stopped pumping when prices were too low. At one time or another all but a very few put their faith in price-fixing agreements of various types. All of these combinations in restraint of trade, rings or associations as they were commonly called, had but a temporary success.[1] The marketing of

1. One of the major problems plaguing the oilmen in Canada, particularly the producers of crude, was their failure to see that their interests would best be served by cooperation and conservation rather than by cut-throat competition and over production. For an introduction to this problem see Phelps, Fairbank.

petroleum is an area in need of thorough research but it is not to be considered in this thesis except in a very marginal manner.

When the oil from surface wells stopped coming or was not coming fast enough they had to be abandoned, as many were, or made to give more. The way to make the surface well give more was to go deeper, through the rock where pick and shovel were of little or no use but where the drill was.

Drilling represents not only a technological act but also a conceptual view since the oil well, at least the drilled portion, is now purely conductor. If the well is to serve solely as a conductor then it is very uneconomical to dig a large surface well which necessitates the removal of approximately 26,000 cubic feet of earth, cribbing and puddling when one could merely bore a hole to bedrock and continue on through. Very early the dug surface well was supplemented by other methods of reaching bedrock.

As has been shown, the surface well was to go to or close to bedrock, a task involving considerable labour and costing about $3.00 per linear foot.[1] The dug surface well is a finished unit in itself although it may also

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1. Based on data found in the Globe, Aug. 30, 1861.

serve as a starting point for drilling. However, before looking at the means whereby this was done other means of reaching bedrock should be examined. One should not expect to find continuity in method but a break at bedrock. The way to go through bedrock is percussion drilling to pulverize the rock but above bedrock the clay and drift would merely be compacted rather than pulverized by percussion drilling.[1] The material above bedrock needed to be dug out by one means or another. The simplest methods have been examined and it is other means that must now be examined.

The year of the spouters and flowing wells in Enniskillen was 1862 and in the description of one of these wells there is some rather interesting material.

> The usual practice in sinking for oil has been to put down a shaft, 6 to 8 feet square, to the rock and to crib this with timber or plank, and then commence drilling the rock with a 2½ or 3 inch drill. In this case a hole 8 inches in diameter was sunk by means of an auger to the rock, into which a wooden box, 6 inches square, was driven.[2]

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1. Boulders encountered in the clay would be either removed or drilled through with a percussion drill. One way to deal with clay is to use a spudding bit, but I have no evidence to indicate that it was used.

2. Smith, S27-25, March, 1862. The Globe, March 12, 1862, describes the same well: "The well is 283 feet deep. No surface well was sunk, but in its place a hole about 8 inches in diameter was bored by means of an auger to the rock, a distance of 48 feet. Into this bore a wooden pipe, 6 inches square was driven."

Auguring to bedrock was unusual, but it was not new. Here, as with percussion drilling, there are close ties between the search for oil and the search for water.[1] In the early autumn of 1858 preparation was under way to begin drilling artesian wells in the neighbourhood of Sarnia, an area "ill-supplied with water." A Mr. Brown of Maine had

> taken a contract by which he binds himself to procure a good and sufficient augur of 150 feet in length, and 3 inch bore, in joints of 15 feet, and all the iron work required for a gin for working the said augur in about three weeks' time.[2]

Whether or not Mr. Brown fulfilled his contract remains to be seen, but two years later similar equipment was being used in the pursuit of oil on Hillier's farm on Black Creek (Oil Springs). A depth of 57 feet was reached with an augur "which was seven inches in diameter" before

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1. There is not a good history of water well sinking technology that I am aware of. The engineering literature of the 1850s and early 1860s suggests that sophisticated equipment for drilling large bore wells several thousand feet deep was being used in Europe, particularly in France. I suspect very strongly that there is a close connection between water and oil well technology in North America and elsewhere but have not pursued the matter.

2. Globe, Oct. 21, 1858.

they "struck a vein of gas" which made it necessary to discontinue work for some time.[1]

It is not known whether or not the bore hole was piped (cased) or left as bored, but if it were not piped it would probably start to cave in soon after completion.[2] A later report leaves no doubt as to what is done as regards piping.

> For rock wells they frequently sink a well like a surface well and then drill, but more frequently the soil is bored out with a large augur until the rock is reached, 40 to 70 feet. Then piping, like pump logs, is put in and driven down snug on the rock.3

It should be noted that the author of the above says that auguring is used "more frequently" than digging for surface

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1. *Globe*, Nov. 16, 1860. When an attempt was made to begin drilling, a 25 pound drill was supposedly thrown from the bore a distance of 100 feet.

2. During the 1860s the terms piping, casing and tubing were used interchangeably. The term casing should refer to the material used to line the bore hole. Piping or tubing is inserted into the unlined bore hole or inside the casing and serves to conduct oil to the surface. The head and foot valves of the pump would be inside the piping or tubing.

3. *Globe*, Aug. 30, 1861.

wells, whereas an earlier reference[1] describes it as not the usual method and another source states that "all wells in operation here have been dug; the surface wells until oil has been found; the rock wells until the rock has been reached and the boring is commenced."[2] It is not possible to say just how popular auguring to bedrock was in the 1860s. The confused and indistinct vocabulary of many a reporter renders it extremely difficult to know what is happening. Witness another part of the same report which states that all of the wells are dug and then mentions that two augur holes were bored to 42 and 41 feet.[3] The report is not without merit as it gives some insight into the problems faced by the augurers.

> ... an augur hole was bored by Messrs. Monnahan and Liddell, to a depth of 42 feet. Water was struck and the hole filled. Three feet from it another hole was bored. A depth of 41 feet was attained when a large boulder stopped further operations until a steel drill was procured. But not a drop of water was met with -- not even

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1. Smith, S27-25, March, 1862.
2. Globe, Sept. 2, 1861.
3. Globe, Sept. 2, 1861.

> sufficient to supply the little necessary
> to the working of the augur.[1]

The steel drill referred to would have been a percussion drill of the type used for penetrating bedrock.

The diameter of the augurs, although frequently not given, when mentioned, varies from seven inches to[2] "several feet in diameter".[3] It is difficult to imagine why such a large augur would have been used when the normal size seems to have been "an augur which bores around and scoops out a seven or eight inch hole."[4] A clue as to a possible reason comes to four years later

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1. Globe, Sept. 2, 1861. Although no well is mentioned in connection with the claim it is stated that "One old driller claimed the top rock was so shattered in one well that they could not keep the water in the hole to drill." Arthur B. Johnston, Recollections of Oil Drilling at Oil Springs Ontario (Tillsonburg, Ont.: Harvey F. Johnston, 1938), p. 14. [Hereinafter referred to as Johnston, Recollections.]

2. Canadian News, June 19, 1861. The augur mentioned was said to be used for exploratory purposes preparatory to digging, curbing, and puddling surface wells. I have seen no other articles in which an augur is said to be used for this purpose and am not clear as to why this procedure would be followed as once oil were found it would seem to be a waste of effort to then dig a surface well. This well was the work of R. Faulkner of Zone Township and the article claims that he was a very careful and methodical worker. I have never seen his name mentioned at any other time during my research.

3. Canadian News, Feb. 27, 1861, p. 70. The augur was used in Sombra and went to at least 57 feet.

4. Canadian News, Aug. 24, 1865, p. 119.

from an account of a well at Bothwell.

> The tower of this derrick was not yet completed, nor, indeed, was the house. But a temporary windlass had been put up and the workmen were boring the surface soils with a very wide and heavy auger, weighing 250 pounds, which was keyed into the stem. The stem was connected by means of joints and could be extended to any length. There were two lips to the auger, one designed for cutting and the other for lifting .... The surface hole they were digging was 12 inches in diameter, the usual diameter being 4½ inches. I inquired the reason of this, and the reply was that at a given depth the auger would come in contact with a stratum composed chiefly of large boulders, and it was necessary either to bore through these, aided by an iron piping to steady the operation and keep the earth from falling across the auger-way, or to raise 16 boulders and cast them out at the top of the well. This last was considered the most easy and practicable. Hence the surface hole was enlarged to admit of the ejection of the boulders from below ... the core or boring (solid) of the well was two feet and a half. The machinery was of the rudest kind, but effective enough. By means of the borer they raised every time nearly a yard of clay, and before nightfall they had gone down some sixty feet below the surface. As soon as they struck the rock they intended to use the small bore, and continue to use it until they found oil. This is the general practice of the diggers, although some of them prefer and use the four-and-a-half inch hole from the beginning to the end of the operation, boring ... clean through the boulders.1

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1. Canadian News, Aug. 17, 1865, p. 103. "Stone Hooks for lifting stones out of surface" wells are one of the items listed for sale but not illustrated in a catalogue of the Oil Well Supply Co., Petrolia, Ontario (n.p., n.d.), p. 17. The catalogue for which the title page and other pages are missing has no publication data. Murray Bradley, President of the Oil Well Supply Company believes that it was published in the 1890s. [Hereinafter referred to as Oil Well Supply]. The account quoted from the Canadian News is probably incorrect in one detail as the "4½ inches is the usual size of rock drills not augurs.

The Bothwell and Enniskillen oil fields differed considerably in the material overlying the rock. At Enniskillen it was mainly clay with some gravel, sand, and rocks or boulders with a total depth of about fifty feet. At Bothwell one usually had to penetrate at least three sometimes four times the fifty feet of Enniskillen and although rocks and boulders were less frequent they were not totally absent. The biggest problem at Bothwell and one also encountered in Enniskillen was strata of "quicksand" which rendered "it all but impossible to dig a large well hole with pick and shovel."[1]

Although water flooding was serious in both areas it was worse in Bothwell. An article in 1863 identified the major natural obstacles at Bothwell as "quicksand and boulders", the fact that the wells were "liable to be flooded with water" and the depths necessary before reaching bedrock.[2] This revelation should have surprised no one. The conditions at Bothwell made it impossible or impractical to use the method used early in Enniskillen: digging and curbing to bedrock. Bothwell was more a centre for innovative practice than Enniskillen.

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1. Canadian News, Aug. 24, 1865, p. 119.
2. Canadian News, April 16, 1863, pp. 249-250.

Varying geological structure above bedrock and the inexperience of the oilmen who were learning to live from and with the oil made for great variety in technique during the early 1860s. An ingenious method of reaching bedrock was practiced by a Mr. Fowle who was sinking a well on the creek flats near Petrolia.

> Mr. Fowle is driving iron tubes in sections 10 feet long, connecting them with a heavy wrought iron collar. These tubes are an inch in thickness and 6 and 3/4 inches in diameter. A small steam engine of about 7 horsepower is used for driving. The principle used is the same as pile driving, except that the hammer is of wood instead of iron, and only 1,200 pounds weight. Mr. Fowle told me he could drive a section of 10 feet in an hour and a half. He expects 5 lengths to reach the rock, when he will bore the core out of the tube ...[1]

The method might have been similar to what Tripp had in mind in 1857 when he dug to 27 feet and got oil and water but not bedrock and so attempted another method to go deeper.

> Afterwards an attempt was made to drive an iron pipe down in the well, but when the pipe had been driven a considerable distance, it broke and the well was abandoned. This well was commenced some six years ago.[2]

It is quite possible that what they had in mind was a method similar to that used by Mr. Fowle. That they had

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1. Globe, June 25, 1861.

2. Globe, May 4, 1863.

a steam engine to do the driving is not improbable as Bothwell, on the banks of the navigable Thames, did not present the transportation problems of Enniskillen. Williams and Tripp did not succeed because the pipe bent which is what would happen when a rock was hit; neither a pipe nor an auger were equipped for going through rock. The previously mentioned augerer for whom things were not augering well at all should be kept in mind. "A depth of 41 feet was attained when a large boulder stopped further operations until a steel drill was procured."[1] In Enniskillen meeting boulders and rocks and gravel in the drift would be a relatively frequent occurrence. When driving pipe down, hitting a rock would be serious if not disastrous as the pipe would be bent, closed, driven off course or some combination of these.[2] Withdrawal would be difficult if not impossible. It is for

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1. Globe, Sept. 2, 1861.

2. Perforated pipes with a pointed end were driven into the earth in this fashion for water wells but this would not work for oil wells penetrating bedrock as the idea was to use the pipe driven down as a guide to drill through into bedrock.

these reasons that this method was probably used more successfully on a regular basis in Bothwell where conditions were more favourable and it is with reference to the Bothwell oil field that the earliest reference to this mode of penetrating the earth is found.

"Dr. Seymour and Co. have driven a pipe to the rock."[1] No more information is given other than the usual happy announcement that "the prospects are more encouraging than they were at Pennsylvania." The basic method seems to have come to stay as it is referred to in 1862, in spite of trouble from boulders.[2] The following year, 1863, brought the first evidence of modification of the system and the hint that all was not well. It was being used in conjunction with a 'normal' surface well. " ... after the well is sunk generally to the depth of about fifty feet, an iron pipe, like a street water pipe, must be driven by machinery down till the rock is reached."[3]

The same article also introduced two other innovative systems. One was as well known as "Knight and Pope's"

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1. Canadian News, Nov. 21, 1860, p. 164.
2. Canadian News, June 5, 1862, p. 361.
3. Canadian News, Dec. 31, 1863, p. 426.

> This well has been commenced on a new plan, viz., boring through the earth with a large auger and sinking a wooden pipe tipped with iron. The Wooden pipe is very cheap, only a few cents a foot, while iron is $3 a foot; and if the wood will serve the purpose, a great saving will be effected. The first hole bored by the auger caved in before the pipe was inserted. Another hole has been bored and the pipe put in a short way. Mr. Knight, who has devised the new plan, is an intelligent American mechanic and is confident of ultimate success.

The other new plan is one for which the information is less complete.

> Mr. Wm. McMillan, formerly of Glasgow, Scotland, and also a merchant in Toronto, has a farm on the south side of the river, and, knowing that boring for coal was extensively pursued in Scotland to a great depth, came to the conclusion that it would be well for him to despatch an order to Scotland for miners, tools, and piping. They were forwarded accordingly, came duly to hand, and were set to work .... Their operations were commenced about two weeks ago and have proved a wonderful success. They are already down 116 feet, and are said to be on the rock with good indications of oil. This is the quickest and most satisfactory boring operation yet attempted. The Scotchmen do not drive the pipe by blows -- they press it down; but, as I have not yet seen them at work, I shall not attempt to describe the operation. They say this work is mere child's play compared to what they have been accustomed to in Scotland. It may be worth while for some of their brothers in the old country to note these facts. There is plenty of work for any number of men here in boring for oil and salt.

It is now only fair to ask how successful these new methods were. Initial response was very favourable for the latter.

> Mr. McMillan, from Scotland, has two wells going down and is about commencing another two ....

> His operators are out from the "auld country," and they have left our native well sinkers in the rear by occupying but days where weeks before were employed in sinking. Not only this, but they will sink a well with less expense than is required to furnish the tools for the original plan -- besides being so much simpler and more successful. It has made a grand revolution in the business by doing away with the cast-iron pipe, heavy ropes, engines, and many other costly materials that frightened men of limited capital; but they may all come in now, for no person will deny that it is the first money-making business in America.[1]

An important point is that cast-iron pipe was not used; an informed guess is that the pipe being sunk was "what was called Scotch casing, similar to heavy stovepipe, soldered together."[2] I have found nothing further to add to the technical information about this process other than by 1865 it was a method of the past. The "artesian borers from the old country" eventually "found ... a good show of oil, and developed it to about two barrels a day. But the hole was too small and the piping broke, and the result was that they finally abandoned it."[3]

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1. Canadian News, Jan. 28, 1864, p. 54.

2. Johnston, Recollections, p. 4.

3. Canadian News, Aug. 17, 1865, p. 103. There is some evidence to suggest that McMillan's success may have been more substantial than 2 barrels per day, viz. "40 to 50 barrels per day" but one cannot be sure that it is the same McMillan and/or the same well as in the article cited there is no reference to the method of sinking and considerable time had elapsed since McMillan initiated his 'unsuccessful' method. See Canadian News, Dec. 22, 1864, p. 387.

There is little to be gained by lingering over the 'failure' of McMillan. The innovators at Knight and Pope's well fared even worse than McMillan.

> ... this wooden pipe is not the thing. It is sure to collapse .... The greatest sufferers here from using wooden pipe are Messrs. Pope and Knight, Hall, Cook, and Thayer.[1]

They may have been suffering but they did not intend to do so for long. Although the complaint had been made that "it takes months before artesian pipes can be obtained from Philadelphia, as that is the only place where they are made"[2] Messrs. Pope and Co. soon had the well "in which the wooden pipe had collapsed ... in full blast with artesian pipe."[3]

By 1864 the experiments in Bothwell had clearly indicated the best method of reaching bedrock in that area and the procedure was more or less standardized.

> At first attempts were made to get to the rock in the regular method, but this was found to be impossible; the depth required, together with the quicksands, rendered it impracticable. A very great deal of money was spent in vain attempts at "cribbing" ere the effort was given up. A very successful method has been adopted in its place. A large hole is first bored in the ground to a distance of a few feet, say 12 or 15, and 10 inches in

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1. Canadian News, Nov. 24, 1864, p. 326.

2. Canadian News, Nov. 24, 1864, p. 326.

3. Canadian News, Dec. 22, 1864, p. 387.

> diameter. Into it an iron pipe, like a heavy stove-pipe, is forced. The bore is then proceeded with, but at a reduced diameter equal to that of the interior of the pipe. When a depth of a few more feet has been attained, a smaller pipe is slipped down the interior of the first pipe into the hole, and so until the rock is reached. By the time that is done the diameter of the bore will have decreased to an average of 5½ inches.[1]

In the description quoted immediately above it is mentioned that "wooden piping is frequently used instead of iron" but if used it could not, on account of its thickness, be used in the method described. It is suspected that as was often the case the "special correspondent" made a hurried trip in which he absorbed both the old and the new and was not always quite sure which was which. The correspondents were not oilmen but were in fact 'tourists' and complete consistency should not be expected. The same correspondent's comments on the source of power should be read with scepticism.

> The surface bore is put down by hand power, and very rough machinery, involving a great waste of labour, is used. Some of the men thus employed are Cornish or Scotch miners, who refuse to adopt any "new-fangled" plans of doing business. The exercise of a little ingenuity and the use of steam would save them an immense deal of trouble.[2]

The connection between coal exploration and mining in Britain and oil exploration and production in Canada

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1. Canadian News, May 18, 1865, p. 314.

2. Canadian News, May 18, 1865, p. 314.

West was also noted in Ure's Dictionary of Arts, Manufactures, and Mines, where it was noted that "the methods employed ... for boring oil-wells are usually of a very simple character, and do not differ very much from those used in this country for trial-borings in coal measures." However there was one system based on coal mining practice that was not as simple as the more conventional system of boring.

> A modification of Fauvelle's system, having hollow rods with a continuous discharge of the detritus, was in use at Oil Springs, Canada West, last summer. The boring-bit has a hollow stem, the cutting edges being formed by three stout radiating pieces of steel. In the angle formed by these pieces, and their junction with the stem-brass, valves are inserted which allow the detritus to enter the rod through which it rises, and is discharged in jets at every fall of the cutter. The lifting of the borer is effected by toothed levers, similar to those of a safety-catch used in collieries, which fall together by their own weight, and take hold of the rod at the end of the stroke; and are released by tappets attached to the boring-frame or derrick, striking against their outer ends when the rod is at the top of its stroke.[1]

It is not known how successful the method was although at first, as with most innovations, it was praised.

> A new kind of drill is now in successful operation, employed by Mr. Bruce and the Hartford Company. The novelty consists in that, instead of using a sand pump, the drill is kept going all the time,

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1. Robert Hunt, ed., Ure's Dictionary of Arts, Manufactures, and Mines (6th ed.: London: Longmans, Green, and Co., 1867), Vol. III, p. 405.

> and the same pump, or rather apparatus that answers the same purpose, is attached to the drill, and thus drilling and pumping are carried on at the same time. Should oil be struck it will also be conveyed to the surface and saved as fast as the vein supplies it, a great convenience and improvement on the old plan.[1]

Very quickly the system got into trouble and after hearing of some trouble it is heard of no more.

> Mr. Bruce is making very good head-way in very hard rock; he is now about 200 feet in the rock, but, like others, he, too, has had an attack of break-down, which detained his operations about ten days.[2]

I strongly suspect that Mr. Bruce was using the plan mentioned in Ure's Dictionary but whatever the method it disappeared.

Numerous commentators have recorded that once bedrock was reached the process was the same in Bothwell and Enniskillen. This is an important point as bedrock represents a watershed in drilling technique. Before examining the nature of this watershed the methods of reaching bedrock in Enniskillen should be examined. Enniskillen and Bothwell shared many techniques. The utilization and abandonment of wooden casing in Bothwell has been discussed; it was tried in Enniskillen at Oil Springs. The main function of the casing extending

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1. Canadian News, Aug. 10, 1865, p. 88. From the Oil Springs Chronicle, no date given.

2. Canadian News, Sept. 21, 1865, p. 187. From the Oil Springs Chronicle, Aug. 19.

to bedrock, be it wooden or metal, is basically twofold. One function is purely structural: to prevent the wells of the surface bore hole from caving in. The other function is to keep debris and water out of the rock bore. The casing had to be strong and had to be put in carefully. Failure to bed the casing properly on bedrock could result in considerable lost time. One well in the Bothwell region had quicksand come in "under the tubing, which was not properly upon the rock, and filled it, and they are now engaged in cleaning out for another start."[1] Needless to say a new pump was also the order of the day.

Wooden tubing, more properly casing, was tried in Enniskillen as well as in Bothwell with more persistence but apparently with no better results. A report of August, 1861, states that after reaching bedrock with an auger "piping, like pump logs, is put in and driven down snug on the rock."[2] Another account, this one from 1862, speaks of an 8 inch diameter auger bore to the rock and "into the bore a wooden pipe, 6

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1. Canadian News, Jan. 28, 1864, p. 54.

2. Globe, Aug. 30, 1861.

inches square was driven."[1] Two separate developments suggest that the wooden casing was little or no more satisfactory in Enniskillen than in Bothwell. The first is that iron pipe seems to have been used in most of the wells. The second is an admission that wooden pipe had not been satisfactory but the defect was going to be rectified by Mr. Lockhart's system of wooden casing.

> The destruction of iron piping in the wells, through action of acids, has been to many adventurers a loss of money, leading almost to loss of hope, loss of heart, loss of faith in petreolic success. Iron one inch thick has been corroded and perforated by acids in three months. Mr. Lockhart found that the circular tubes of wood, sent down the hole behind the drill to protect the iron piping, went to pieces in the course of two or three, or at most four months. They were composed of narrow pieces with iron nails and hoops to hold them together. The metal tube was within this wood casing, and on failure of the casing was speedily corroded and destroyed. Now he has contrived a different kind of wooden tube. Pieces of pine or other soft timber, free of knots, are cut to lengths of fifteen feet. Each is rounded on the outside to a half circle. It is hollowed in the inside to a half circle five inches diameter, thickness of the body five-eighths of an inch. Two of these halves placed together form a whole circle. One-half overlaps the other at the end by three feet. A copper band holds them together. The next section fits into the space left by the overlapping of the last piece. It is in turn overlapped by its fellow. The copper band again binds them. Thus they are put down into the drill hole

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1. *Globe*, March 25, 1862.

> to protect the iron tubing within which work the drill tools, subsequently the pump, from the action of acids in the rock; or, where there is loose earth or side springs of water, to keep these out of the shaft. The first section, as it is about to disappear, is hooped to a second, and upon that is placed a third, and so on in succession, until this wooden casing is far down as may be desirable to send it. This simple contrivance with the absence of iron nails is Mr. Lockhart's latest step in advance of those who surround him. A carpenter is seen in the shop belonging to the company, behind the treating-house, fashioning these sections of wood tubing. He makes six sections in a day.[1]

Lockhart's system did not find permanent favour but does serve as an example of some of the thinking directed towards a problem which has yet to be solved. Lambton crude is particularly corrosive and is very hard on pipe in wells and in refineries. In spite of its shortcomings, iron was the best of the available evils and was the predominant pipe material. The wood did not serve as an oil conductor in Bothwell or Enniskillen. The wooden tubing or casing protected the piping which extended into the bedrock and conducted oil thence. It is the penetration of this bedrock that is to be examined before turning to the casing below bedrock.

New techniques were necessary as soon as bedrock was reached. Drilling was the only way to penetrate bedrock. Not all wells were started with drilling in mind;

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1. Canadian News, June 14, 1866, p. 375.

some dug surface wells which had ceased to give oil, were abandoned and then given a new lease on life by drilling.[1] For other types of wells and for many of the dug surface wells, drilling was part of the original plan.

The first step in drilling, irrespective of the power source, was to provide for the drilling tools in order that they get started straight and hopefully continue that way. If bedrock had been reached by an auger then casing would be "driven down snug on the rock"[2] to serve as a guide for drilling as well as a means of sealing the upper part of the well. For wells which had been dug to the rock, preparation for deep drilling would take place by boring a hole "say 2½ or 3 inches in diameter," or whatever bore one intended to use in the rock, into the rock for about a dozen feet. An iron pipe would then be "driven into the hole in the same manner as piles are driven into the earth."[3] The drill would then be introduced.

The drill was the lowermost of a number of pieces of equipment known as a string of tools. A complete string of tools would consist of drill bit, auger or drill stem,

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1. See Globe, Mar. 12, 1862 and Globe, Sept. 12, 1861.
2. Globe, Aug. 30, 1861.
3. Globe, Mar. 12, 1862.

jars, sinker bar, and sucker rods and/or cable. The earliest method of drilling practiced in Canada West was that of kicking down a well with a spring pole rig.

> The drill is suspended by a short rope from a beam overhead. In order to continue boring, it is necessary to get a reciprocating motion, and the object has been attained in this way. An upright post is erected by the side of each well. Across the top of this post is placed a tapering spar, the thin end of which just crosses the well, the thick end being fastened to a tree .. or if none ... can be found; a weight is attached to the end; but more generally, care having been taken to select a spar heavy enough for the purpose, no additional weight is required. It is now evident that if the end next the well be bent, the spar will right itself the moment the pressure is removed and that the desired motion may thus be obtained. Accordingly the rope attached to the drill is fastened at a distance of about 3 feet from the end of the pole. From the extreme end hang ropes with stirrups, into which the workmen place their feet, and by alternately pressing and removing the pressure, the drill is lifted the distance of 6, 8 or 10 inches as the case may be. Day after day the workmen thus "treadle" until the oil is reached.[1]

The above description, with one modification, may be said to fit all of the spring pole rigs used. Some were not equipped with ropes terminating in stirrups but rather the rope led to a pivoted platform which would then be alternately stepped on and off;[2] this is what should be called a 'treadle' with which one would treadle a well whereas with the stirrups one kicked

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1. Globe, Mar. 12, 1862.

2. See plate III.

down a well. As with much that is described in this thesis it is crudely elegant. Spring pole drilling was not an oddity out of its element but an appropriate response to a given set of conditions.

In much that has been written about spring pole drilling and pumping it is customary to say that this is what the Chinese also did[1] and then to drop the matter there which is to drop the story at the very point that it should start. The spring pole was used in Canada as a power source when others were not available or were uneconomical. It was economically and easily constructed from readily available natural materials as well as being simple even if not pleasant to operate. These characteristics made it an ideal power source although some might be tempted to derisively label it a technologically unsophisticated power source. The fact that a power source used in Canada was utilized much earlier in China and Europe serves only to illustrate the direct and pragmatic approach utilizing limited technological resources that characterizes much of the history of technology in developing areas in Canada,

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1. For an introduction to this type of writing see for example any of the following.
Globe, Sept. 7, 1861.
The Canadian Native Oil Company, The Canadian Native Oil: Its Story, Its Uses, and Its Profits: With Some Account of a Visit to the Oil Wells (London: Ashby & Co., 1862), p. 15. [Hereinafter referred to as Canadian Native Oil].
Victor Ross, Petroleum in Canada (Toronto: Southam Press, 1917), pp. 31-32.

particularly during the nineteenth century.[1]

Spring pole drilling or pumping required considerable human labour and well operators soon began to look for alternate power sources. It is undoubtedly a reference to kicking down or treadling a well that mentions "a gang of 8 or 10 men ... busily boring 2 wells",[2] a considerable expenditure of manpower. The deeper the well the more men would be needed, a good reason for switching to steam: "each 100 feet requires an additional man to work the drill. After a depth of 300 feet has been attained, a steam engine is generally employed."[3] Much rock drilling was started with a spring pole but the figure of 300 feet is an extreme depth at which to start using steam. More representative is

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1. For an introduction to the use of the spring pole as a power source and its applications see Robert S. Woodbury, History of the Lathe to 1850 (Cambridge, Massachusetts: M.I.T. Press, 1964), pp. 34-44, and Bertrand Gille, "Machines," in Charles Singer, et. al., ed., A History of Technology, Vol. II: The Mediterranean Civilizations and the Middle Ages (London: Oxford University Press, 1967), pp. 643-645. Dr. Loris Russell of the Royal Museum informs me that spring poles were used with pit saws in Upper Canada in the early nineteenth century.

2. Smith, S25-48, June 22, 1861.

3. Globe, Mar. 12, 1862.

probably a figure closer to the "42 feet in the rock" that Sweet and Co. reached before deciding to wait for the arrival of an eight h.p. steam engine for deeper drilling.[1]

Early 1861 was the time of testing for steam and rock drilling. In January the big news was rock drilling -- "three rock drillings which would be worked as soon as engines can be procured to pump them."[2] This was a new approach in the "probing and torturing"[3] of the earth of Enniskillen. A report of January 12, 1861 speaks of only three wells having been drilled in the rock and these at depths of forty to fifty feet in the rock. As was the case with so many wells which had "not yet got to pumping," the "indications" were such as to see them as "the best wells in Canada." However, after the customary show of optimism, the uncertainty is shown in the grimly factual statement that "they will soon be pumping and that will tell

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1. Globe, Sept. 6, 1861.

2. Globe, Jan. 25, 1861.

3. Robb, "Petroleum Springs", 316.

the story."[1] As late as March 29, 1861 it was reported that there were still only three wells bored in the rock but that more were soon to come, one by a Mr. Fichett of Rochester who was presently at home getting tools for the job.[2]

Rock drilling vindicated itself and soon became standard practice for new wells as well as for resurrecting abandoned surface wells and those no longer yielding in paying qualities. Coincident with the growth of rock drilling was the arrival and accelerated rate of arrival of steam engines. The "steam engines brought in during the winter"[3] of 1860-61 and afterwards were quickly put to work in drilling, pumping, sawing wood and running refineries. The roads used to bring the steam engines into the oil fields were disgraceful: the steam engines were often cantankerous and hard to repair, but 1861 saw them established as an essential and integral part of the oil industry.

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1. Globe, Feb. 15, 1861. Although not published until Feb. 15, the article was written on Jan. 12. I believe these wells to be those of Williams, Pile, and Dickson & Vaughan. See Globe, Jan. 25, 1861.

2. Globe, Mar. 29, 1861.

3. Observer, May 31, 1861, based on extracts from the Guelph Advertiser.

The introduction and regular utilization of steam as a major power source is an important benchmark in the maturation of the Canadian oil industry. Steam was an agent of stability, regularity and rationality in an industry rather lacking in these qualities. However, many outsiders were unaware of the importance of steam. Spring poles were far more picturesque and beginning in 1862 with the first gusher the flowing wells received a disproportionately large amount of news coverage. The existence of a handful of spouters warped the perspective of many. Early in 1863 the flowing wells stopped flowing and many felt that the end of the oil industry in Canada was at hand. Calmer and more rational heads, heads more acquainted with the industry as a whole rather than as a newsworthy spectacle, saw the cessation of the flow differently.

> For our own part, we do not regard the stoppage of the flowing wells as any indication of an exhaustion of the supply, but merely as an evidence of the exhaustion of the power which forces the oil to the surface.1

The answer was simple. All that was needed was a new source of power and steam was that source. The steam engine became even more firmly entrenched with the end of the spouters and was not to be displaced until the

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1. Oil Springs Chronicle, Jan. 22, 1863, as quoted in Victor Lauriston, "Deep Well in Oil Springs Area Advocated When Gusher Failed and Confidence Waned in Field", an unidentifiable newspaper article, Smith, S29-2.

end of the century. These engines were not magnificent showpieces but rather modest working engines usually in the range of six to eight horsepower,[1] a figure which is representative of the first few years of the 1860s. During the second half of the decade the power of the average engine was two or three times that of its predecessors.

The flowing wells and spring pole drilling obscured the importance of the steam engine just as the jack-of-all-trades wildcatter overshadowed the more competent specialist who was a driller and nothing else. Perhaps it is more romantic to think of wildcatters who scraped together a few dollars, leased some land, kicked a well down, struck 'ile',[2] treadled it up and perhaps even distilled it before selling it but as the 1860s wore on these were increasingly rare although they did not disappear. Many wells were drilled by owners but <u>the</u> well driller was a specialist. The driller had to deal with many problems but most were within the narrow confines of his trade.

"Though most of the owners of the oil wells, both

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1. <u>Globe</u>, Sept. 12, 1861 and <u>Globe</u>, Sept. 6, 1861.

2. The term 'ile' was frequently used by Canadian newspapers.

at Petrolia and Black Creek, have sunk them with their own hands, yet others will contract to do so."[1] Such was the situation in March 1862 and yet even earlier something akin to the specialist appears. Tripp dug at least one well for Williams in 1857[2] and a man named Dobbyn dug the Underhill surface well[3] and yet I do not feel that we have here specialists but rather the work of labourers who would do any number of jobs. The first hint of a free lance specialist with a steam engine comes in April of 1861. "There were two steam engines at work in the diggings, pumping out the oil; they do a good business."[4] Whether these same engines were turning to the business of drilling is not known but four months later contracts were being given to dig wells. A report not of the unusual but of the apparently commonplace is that

> ... the slow progress of drilling is carried on by foot, horse-power or steam engine, sinking from a few inches to perhaps ten feet per day. This drilling is done at $2.50 per foot.[5]

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1. Globe, Mar. 12, 1862.

2. Globe, May 4, 1863.

3. Smith, S25-19, July 19, 1860.

4. Free Press, April 6, 1861.

5. Globe, Aug. 30, 1861. In the same report it is said that "surface wells are dug and finished at three dollars per foot."

The next month the following report appeared.

> No piping is employed. The hole is made in the rock by means of drills, varying in weight from three to four hundred pounds. Four men are required to each well .... The wells are generally sunk by contract. Two dollars per foot for all under one hundred feet; two dollars and a quarter for every foot in excess.[1]

The price reported for March 1862, a price given by the reporters as the "average price", is "for the first hundred feet ... $2.00 per foot, for the second hundred $3.00 per foot and for the third $4.00" with a distance of 3½ to 4 feet generally made in a day;" These seem to be prices for kicking down or treadling a well as "each 100 feet requires an additional man to work the drill. After a depth of 300 feet has been attained, a steam engine is generally employed."[2] A quotation from the previous month gives the expense of drilling as "first 100 feet, $1.50 per foot; every additional 25 feet, 25¢ extra."[3] Another contractor offered his services at $2.00 per foot for the first 500 feet and $3.00 per foot for the next 500 feet.[4] Using these various price quotations for a 350 foot well a range of drilling prices is obtained. At $3.00 per foot for surface and $2.50 per

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1. Globe, Sept. 2, 1861.
2. Globe, Mar. 12, 1862.
3. Leader, Feb. 12, 1862.
4. Globe, June 2, 1865.

foot for rock, assuming 50 feet of surface well, the well contract would cost $900. The next contractor would receive $762.50. The driller identified by a reporter as "average" would earn $900 for 300 feet and if his rate increased at the same rate as prior to 300 feet the total cost would be $1150. The last driller, the one with the most complex pricing scheme, would charge $775.00.

By 1869 there were at least ten men in Petrolia who regarded themselves as drillers by occupation.[1] The well driller was really a specialist at three tasks -- drilling, casing, and fishing -- each requiring its own skills and equipment. Drilling and fishing were the most difficult and fishing was the most vexing.

In spring pole drilling the required reciprocating motion was achieved by depressing the spring pole in order that the string of tools would fall freely and then be raised as the spring pole straightened itself. As the hole went deeper more rope or cable would be played out. Rope would not be played out with every stroke but only with every inch or two of penetration. The reason for this may be seen quite easily. Consider a

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1. Smith, S21-26, July, 1869.

case in which the stroke at the spring pole is ten inches. In actual operation the drill should fall less than ten inches because it should hit the rock before the end of free fall is reached. Therefore the rope might be set so that before the start of fall the drill is seven inches from the rock thereby allowing almost 3 inches of penetration before adjustment of the rope or cable. The actual figures would depend on the driller's skill as he kept in mind that the drill must hit rock before the end of free fall. With the pole depressed and the drill in the rock there should be some slack to help snap or jerk the drill free, that is to say that the string of tools is started on its upward journey by a pole with upward velocity and therefore kinetic as well as potential energy, rather than a depressed spring pole with zero velocity, potential but not kinetic energy, connected by a taut rope to a heavy string of tools imbedded in rock.

Drillers wanted to make the steam engine do the work of the men kicking the well down i.e. induce free fall in the string of tools and the work of the spring

pole i.e. raise the string of tools.[1] The steam engine was connected to the string of tools via a crank, pitman arm, and walking beam.

The string of tools consisted of several elements. Lowermost on the string of tools is the "drilling bit." In the catalogue, circa 1895, of the Oil Well Supply Company, Petrolia, Ontario, drilling bits vary in size from 3½ to 12 inches across the cutting surface with weight varying 40 to 150 pounds.[2] The bit would be threaded onto the end of a sinker bar, a long iron bar whose purpose was to add to the weight of the string of tools as well as helping to keep the string going straight. The sinker bar and drill were two separate units rather than one so that they would be easier to handle, particularly when the drill needed sharpening. However, such was not always the case as Arthur Johnston notes:

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1. It should be noted that theoretically one could work with a spring pole rig as described here: spring pole, rope and drill, the latter weighing approximately 400 pounds. Based on descriptions of spring pole rigs the above is all that was used but I suspect that it consisted of more, namely "jars" and a sinker bar attached to the drill which would weigh less than 400 pounds. A lighter drill would be much easier to sharpen as even the most heroic smith might have trouble in wrestling with a 400 pound drill that he wanted to heat and sharpen by hand.

2. Oil Well Supply, p. 20.

> Some of the spring-pole tools were bars of steel sharpened at the ends with no joints; when the bit points had to be dressed, the drillers shouldered them and carried them to the shop. I have seen some of these tools.[1]

Two descriptions leave little doubt that drills of the type mentioned by Johnston were found in Lambton during the early 1860s.

> The cutting portion is of steel, shaped like a common chisel, welded to a round bar of iron, nearly as large in diameter as the iron pipe into which it is placed and generally weighing from 200 to 300 pounds.[2]

Another drill, thrown from its hole by gas, was "a piece of iron 1½ inches in diameter and 8 feet long."[3] Drills as described above would have been far more cumbersome and awkward than the detachable drill bits over which they offered no advantage other than perhaps ease of construction and there is no reason to believe

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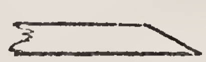
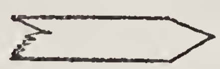
1. Johnston, Recollections, p. 4.

2. Globe, Mar. 12, 1862. I do not know whether a cutting edge shaped like a common chisel would be shaped like that of a wood chisel  or that of a chisel for cutting metal  although the latter is the only one that seems reasonable in view of the nature of the job. The weld would be a blacksmith's forge weld. The truly hard up driller was one who could not afford to have his drill bit sharpened, see Leader, Jan. 27, 1862.

3. Globe, Nov. 16, 1860.

that the detachable bit was not used almost exclusively.

The drills varied in size with the 1½ inch drill mentioned above being the smallest referred to. The only uniformity of drill size during the early and mid-1860s is not one of actual size, but of trend i.e. a trend towards larger sizes. By 1865 the 4 to 4½ inch rock drill is spoken of as the norm.[1] In that same year holes admitting only a 2 inch pump were regarded as "unfortunately ... not sufficient" in diameter.[2] As the year was drawing to a close a correspondent of the Detroit Advertiser admitted that in spite of "provincial dulness, the oil regions of Canada West are becoming widely known as among the most prolific on the continent." He was not blinded by their accomplishments from seeing that there was room for improvement and was going to give the provincials the benefit of his wisdom. After acknowledging the wisdom of the provincials in no longer using the "two and a half or three-inch drill" he added that "a well, to be successful, must be drilled from five to eight inches in diameter, furnished with a corresponding

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1. Canadian News, May 18, 1865, p. 314.
Canadian News, Aug. 17, 1865, p. 103.
Canadian News, Aug. 24, 1865, p. 119.

2. Canadian News, Aug. 31, 1865, p. 134.

pipe and pump."[1] His advice was not taken and the 4½ inch drill and pipe remained the rule although larger pipe was used on occasion.

It seems that most of the drills had a straight chisel-shaped cutting edge but there is record of one experimental cutting edge. I have been unable to determine how well this drill was received but its existence and the rationale behind it should be recorded.

> The drills most commonly used for piercing the rocks are made of flat pieces of steel of the diameter the hole is required to be. An inventor from St. Catharines had introduced a drill in the shape of an S by which, as is easily seen, a larger cutting surface is obtained. It has been used to bore the St. Catharine's artesian wells to a depth of 800 feet, and does its work much more rapidly than those of the ordinary kind.2

Alternating with the drill bit as bottom element on the string of tools was the sand pump or sand sucker, a very necessary tool because drilling would be alternated with debris removal.

> When, after boring for a given time, the men think that so much rock has been loosened as to render it necessary to clear out the hole, the drill is wound up to the top by means of a windlass and the sand pump lowered. This pump

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1. Canadian News, Dec. 21, 1865, p. 391.

2. Globe, Sept. 6, 1861.

> is merely an iron tube with a valve opening inward at the bottom. When let down into the bore, the valve is forced open by coming into contact with the powdered rock, which gets to the inside. As soon as it is raised the contents of the tube pressing on the valve closes it, and so imprison themselves within.1

This type of sand pump or sand sucker could then be emptied merely by turning it upside down and shaking or by unscrewing the valve assembly from the tube or stem of the pump.

Moving up the string of tools from the drill bit, assuming a detachable bit, one would expect to find the drill stem and then the jars. Jars resembled two elongated chain links and were designed to give the string of tools some 'play'. There is no doubt in my mind that jars were used during the 1860s and yet I have found no reference to them at all until the 1870s. This lack of reference to jars, should not be surprising when one considers that there are very few references at all to the various elements of the string of tools -- that curious assemblage of mysterious parts spent most of its life in the ground away from the eyes itinerant correspondents and was so familiar to the residents as

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1. Globe, Mar. 12, 1862.

to need no written description. Screwed to the upper end of the jars one might find another iron bar similar to that to which the bit would be attached or one might find that which is regarded by many as being characteristically Canadian: ash sucker rods. Again, no mention of sucker rods in the early Canadian oil literature but there is the next best thing to it -- an unfortunate accident in Goderich.

Sucker rods are merely slender white ash boring rods. White ash is used because of its straight grain and strength. In 1896 Sir Boverton Redwood described them. "The rods are about 37 feet in length and are fitted with iron screw joints, by which they are connected together." The diameter of the rods was given as "barely 2 inches."[1] Goderich was only one of the many Ontario centres at which the oil fever struck but unlike the fate of many such ventures a dry hole was not their reward. Brine was their reward, rich brine on which a thriving salt industry was built using oil drilling techniques.

At the Prince Well in Goderich the "parting of a

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1. Sir Boverton Redwood, Petroleum (London: Charles Griffin & Company, 1896), Vol. I, p. 178. [Hereinafter referred to as Redwood, Petroleum.]

perfectly new rope" in 1868 led to a six week delay in drilling as it was the cause of "precipitating the drill and follower (weighing 3000 lbs.), 500 feet of drill poles, and 200 feet of rope, to the bottom of the well."[1] Drill poles are also known as sucker rods. It is important to note that both cable or rope and sucker rods were used although the casual visitor to the operating well would have seen only the cable. Reports such as one in 1865 mentioning "cable"[2] must not be interpreted as meaning that sucker rods were not used as it is very likely that they were present but just not visible. By the 1870s the use of sucker rods was regarded as characteristically Canadian but no evidence has been found to validate such a claim.

Incomplete as it may seem little more can be said as to what constituted the string of tools in the 1860s. The one point to be added merely poses an unanswered question. Much of the information about petroleum comes not out of an intrinsic interest in petroleum but because as a generator of and accomplice in so many accidents it made good copy. After

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1. <u>Canadian News</u>, Sept. 17, 1868, p. 180.

2. <u>Canadian News</u>, May 25, 1865, p. 326.

chronicling a fire the Oil Springs Chronicle described its origins.

> As is customary, a small fire had been kindled near by the workmen for the purpose of heating their cement which they use for more securely fastening the drill tools together, and the atmosphere being impregnated with gas a slight explosion, similar to that of gunpowder unconfined, took place, its effects communicating to the oil near by, when what has been described followed. This occurrence, with another of its kind which took place some months ago and which we mentioned at the time, and then cautioned against a repetition of it, should impress upon the minds of all the importance of carefulness and provision against such catastrophes.[1]

It would seem very logical that the cement was being used to prevent the threaded connections between sucker rods from becoming unthreaded or disengaged, an event which would have disastrous results. The sucker rod connections in my possession which definitely date from 1865 show a very poor design which would easily work loose as the male and female connections are square rather than tapered. Redwood describes them as conical,[2] the same conical shape that is evident in connecting pieces in the Oil Well Supply Catalogue.[3] The conical threaded fitting is harder to make than the square but would make a union

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1. Canadian News, Oct. 9, 1862, p. 235.
2. Redwood, Petroleum, I, 278.
3. Oil Well Supply, pp. 22-23.

less likely to part. Further material, when uncovered, will indicate when the design change took place and if it was related to the use of the cement mentioned.

The men who worked with drilling tools had a job that few would envy. Well sites were generally dirty, greasy, and malodorous. The work was heavy, continuous, noisy, and repetitious. It was the type of work that is liable to exhaust and to lull men into carelessness and complacency -- dangerous habits in a job where surprises might be fatal.

> A set of tools, weighing 1,000 lbs., were lifted completely up and thrown some distance from the pipe by the force with which the gas comes up.[1]

Besides drilling the driller had two other major tasks: casing and fishing. Although the terms tubing and casing are sometimes used rather indiscriminately they are not identical. When both are used casing is the larger of the two and serves to reinforce the bore walls and keep water and debris out. Tubing houses the pump itself and is the pipe through which the oil is pumped. Casing wells was not a universal practice in Ontario wells even by

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1. Canadian News, Jan. 3, 1867, p. 7.

the 1890s. For instance, the Oil Well Supply Company, Petrolia, was advertising a packer for an uncased well, i.e. "any well that will not cave in."[1] Where no casing was required the driller had only to insert the pipe containing the pump, the pipe through which the oil would be piped to the surface.[2] If the well had been drilled properly inserting casing and/or tubing was no real problem except that it might be a long wait for it to arrive[3] and when it came there was always the chance that it would not fit.

> The Reid and Smith wells which were to have been pumped this week are thrown back, in the one case owing to the well being too small for the tube and in the other owing to the tube being too large for the well.[4]

If a driller were lucky his problems might be as minor as tubing which "had been put in in a hurried manner, causing ten feet of clay to accumulate at the bottom of the well", a simple matter easily "remedied by the sand pump."[5] Some problems were more serious, one

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1. Oil Well Supply, p. 34.

2. Sometimes a well would give satisfactorily without being cased but would eventually become choked with dirt whereupon it would be necessary to clean, case and re-tube the well. Such a well is cited in Canadian News, Aug. 29, 1867, p. 136.

3. Canadian News, Nov. 24, 1864, p. 324.

4. Canadian News, Nov. 9, 1865, p. 311.

5. Canadian News, Nov. 9, 1865, p. 312.

of the most serious being the collapse of the pipe in the well.[1] Collapsed casing or tubing meant that a difficult decision had to be made: "go fishing" or abandon the well.

Although all cased and/or tubed wells were united by certain elements there was no 'standard practice' in Ontario wells during the 1860s. One of the reasons for the lack of 'standard practice' was the scarcity of proper equipment. But the scarcity of equipment and the variations in terrain and geological conditions were not the major factors. The main reason is that during the 1860s the oilmen were searching and exploring for the methods most suited to their needs. They were trying to find or develop the best method or methods to sink and construct an oil well so that it was more than a financially unremunerative "monument of enterprise in the shape of a hole in the ground."[2]

In all rock wells some type of tubing or casing served as a guide for the drilling equipment or string of tools.[3] A newspaper reporter described such an

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1. Canadian News, Nov. 9, 1865, p. 311, and Canadian News, Sept. 16, 1869, p. 182.

2. Canadian News, June 11, 1866, p. 109.

3. This applies to all drilled wells whether the bedrock had been reached by an auger or by constructing a dug surface well.

installation and noted that

> when the rock is reached; a hole, say 2½ or 3 inches in diameter is bored into it for perhaps a distance of a dozen feet. An iron pipe is then driven into the hole in the same manner as piles are driven into the earth.[1]

As has been shown, a surface well dug to bedrock would be cribbed. Where bedrock was reached by an auger it appears to have been common, perhaps almost universal, practice to pipe or case the bore hole. The casing was "put in and driven down snug on the rock."[2] The purpose of the casing was to prevent cave-ins, keep out water and quicksand as well as to act as an avenue for the equipment to be used in drilling deeper and perhaps for conducting oil from the ground. Quicksand was a particularly ubiqituous offender and would often be the cause for putting casing in a well that would not otherwise be cased.

> When a quicksand is reached, it causes a great deal of trouble, as iron pipes have to be driven down the bore until it is passed to keep the hole clear.[3]

Quicksand might and did enter the rock bore and pump when the casing to bedrock was not properly seated.

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1. Globe, Mar. 12, 1862. Frequently there was also a guide at ground level, see

2. Globe, Aug. 30, 1861. See also Globe, April 25, 1862 for one reference to the use of wooden pipe or tubing.

3. Globe, Mar. 12, 1862.

Mr. Fowle and others using his method of driving pipe before drilling or digging would already have the casing in to bedrock before augering.[1]

Once bedrock was reached there was considerably more variety in procedure than one might expect. One report said that "no piping is employed",[2] a practice which appears to have been followed in 1861 in one of Williams' wells in which "near the top of the bore there is a crevice in the rock through which the oil, if allowed to reach so high, escapes where it goes there is no telling."[3] A number of reports from the following year give clear evidence of the use of pipe in the rock bore. In some, such as a report of "oil and water bursting up in large quantities through the tube"[4] no information is given as to how far down the casing extends. Other accounts are more informative. In one instance pipes

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1. *Globe*, June 25, 1861.
2. *Globe*, Sept. 2, 1861.
3. *Globe*, Sept. 6, 1861.
4. *Hamilton Spectator*, March 10, 1862. [Hereinafter referred to as *Spectator*]. See also *Globe*, Mar. 12, 1862.

were being inserted into a 218 foot well[1] and in another an "iron pipe has been driven down to a depth of 180 feet."[2]

One suspects that casing was not universal and that for a reason, amongst others, that might not at first be suspected, pipe was scarce. "When the oil was struck in one case, the well flowed into the creek for five days, waiting for piping to come from Buffalo."[3] Scarcity or complete lack of necessary parts and equipment with resultant losses was no stranger to the oilmen. Equipment was scarce largely because the industry was new, poorly financed and in a rather remote area with poor transportation facilities. As is to be expected, this state of affairs was very influential in determining the nature of the petroleum industry in Ontario. Given the scarcity of pipe in the oil fields of Ontario in the early years of the 1860s it is probably

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1. Leader, Mar. 18, 1862. This was an old surface well which had been drilled into bedrock.

2. Globe, Mar. 12, 1862. Further evidence for the use of pipes comes from an interesting report of some industrial sabotage in the oil fields, see Smith, S27-31b, Sept., 1862. The report reads in part: "Somebody pulled up the pipes on Mr. Barnes flowing well and allowed ... oil to escape. The Oil Association is blamed."

3. Smith, S27-4, a published letter of Jas. B. Bennett of Oil Springs, written Aug. 10, 1862. I do not know where it was published.

fair to say that its use was not universal but dependent on availability, the judgment of the driller, lessee or owner of the well with emergencies forcing the use of piping or cessation of drilling.[1] With the passage of time casing of wells became more and more a part of near universal practice but, as pointed out earlier, was not universal even by the 1890s. Weak and crumbling walls would often make piping necessary. "At a depth of 100 feet a soft soapstone was met with which caved-in, and rendered necessary the introduction of great lengths of piping."[2]

One of the reasons for casing a well was to help keep the water under control. Whether the driller had a well both cased and tubed or just tubed the basic procedure was the same. As has been shown in dealing with the portion of the well to bedrock, casing, wooden or iron, would be driven down so as to be snug on bedrock in the hopes that surface water and quicksand would be prevented from entering the rock bore. One could not do this in the rock bore as the bottom of it normally had to allow free movement of oil and, unfortunately, its

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1. See for example Globe, Mar. 12, 1862.

2. Globe, Mar. 12, 1862. The well went to 335 feet.

unwelcome companion water. Therefore the object of the driller's manoeuvres was to isolate the water coming in through horizontal water-bearing strata. The equipment used to accomplish this was catapulted into the public eye with the Shaw gusher and is invariably spoken of as if it were first used on that occasion. Closer examination of available material reveals that the "seed-bag" was being used before 1862.

> The artifices employed to prevent an inconvenient quantity of water from mingling with the oil in the well is both simple and ingenious. It is applicable, however, in those cases only where the oil is found to enter the well through a fissure. A hole is drilled about two feet below the vein, the bottom of the pump is plugged, and feed holes are bored in the side of the tube, two feet from the extremity. Below and above the feed holes, two leather bags containing linseed or peas are fastened to the tube, the extremity of which is then inserted into the drill at the bottom of the well, and the feed holes turned opposite to the vein. The bags with peas or linseed are adjusted round the tube, above and below the vein, and packed or puddled as tightly as possible. Water slowly permeates the leathern bag, swells the peas or linseed, and so fills the drill that neither water or mud from above or below can enter the feed holes of the pump in sufficient quantity to interfere with the operation of pumping out the oil. A second pump is introduced for the purpose of drawing off the water above the vein, if it accumulates in quantity sufficient to arrest the flow of the oil in the manner explained in preceding paragraphs.[1]

The oil would collect in the bottom of the pipe, the non-perforated part, and then be pumped in the usual fashion.

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1. "The oil wells in Enniskillen," Journal of the Board of Arts and Manufactures for Upper Canada, I (June, 1861), 145-146.

A project similar to that above was being tried four years later by Captain Dick in a well 326 feet in the rock and bedevilled by water problesm.

> With this well the manager has had much trouble. There is a very great deal of oil in it somewhere; but there is more water, and they have been unable, so far, to stop the flow. The pipes have been taken out a great many times and seed bags placed at various points, but without success. As an experiment Captain Dick has plugged the end pipe and fitted it near the bottom with a seed bag. Above this bag he caused a series of holes to be made through the pipe. One hundred and seventy feet above this he placed another seed bag; the oil and water within this space of 170 feet could alone find entrance into the pipe. When yesterday the machinery was set to work, nearly pure oil was first drawn; but soon after water made its appearance. Sometimes it comes mixed with the oil in large quantities, at other times there is a great rush of oil. The well is evidently a very valuable one; and if the water should not be exhausted shortly, the pipes will have again to be taken up. It is worth the expenditure of a great deal of money to get it into working order.[1]

The seed bag could also be used to reduce and control the flow of oil in a gusher as was done with the Shaw and other gushers. It is probable that when Goderich brine wells were plagued with fresh water getting in the tubing and diluting the brine seed bags were called upon.[2] Seedbagging was very much a part of

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1. <u>Canadian News</u>, May 4, 1865, p. 280.

2. <u>Canadian News</u>, Oct. 4, 1866, p. 213.

the normal procedure of sinking and preparing a well for operation, one reporter giving the figure of nine out of ten for the number of wells that had to be seedbagged.[1]

If seedbagging was a normal and near routine operation for the oil well driller another of his operations was not: "fishing" -- the retrieval of deranged or detached equipment from the bore of a well. Normally it was drilling tools, all or part of a string of tools, that would be fished for but it might also be the casing. Fishing jobs were necessary quite frequently and whenever newspaper editors and/or correspondents took it upon themselves to survey the load of ills and disasters on the shoulders of those in the oil fields references to tools of various kinds lost or stuck in bore holes were sure to be part of the list.[2]

Fishing jobs were usually not just an afternoon's work with jobs of four[3] to six[4] weeks being not unheard of. Given the length of time and therefore money involved, add to this the uncertainty as to the outcome and one is able

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1. Canadian News, Nov. 30, 1865, p. 344.

2. See for example Canadian News, Dec. 22, 1864, p. 387 and Canadian News, Jan. 18, 1866, p. 37.

3. Canadian News, Aug. 10, 1865, p. 85.

4. Canadian News, Sept. 17, 1868, p. 180.

to see that when tools were lost there was a very real possibility that to simply abandon the well would be the most economically sound reaction. One newspaper reported that "the sand pump has unfortunately dropped and it may have to be abandoned."[1] It is not known whether or not the well was abandoned but another well, a "first-class well", was abandoned rather than face the expense and uncertainty of a fishing job.

> ... the Blackburn well is not pumping. This is owing to the casing having collapsed and some other serious trouble which it would have cost more to get rid of than to drill a new hole. The latter course Mr. Blackburn proposes taking by moving his derrick two or three feet from the old hole and drilling an entirely new one from the top. This well was up to a few weeks ago a first-class well, and we presume would yet pump largely if properly cleaned out and set going.[2]

Not all apparent obstructions in wells necessitated fishing or abandonment. "The Wood well is turning out a first-class well. There is a full set of tools stuck in the bottom and yet the pump throws

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1. Canadian News, Dec. 22, 1864, p. 387.

2. Canadian News, Sept. 16, 1869, p. 7.

five to seven barrels per day."[1]

When the drilling, casing, and fishing were over it was time to pump the well. The pumping of wells has been discussed to some extent and only two aspects of steam pumping will be discussed here. The first to be discussed is that of the multiple use of steam engines, that is using a steam engine to perform more than one task at any given time. The second area of discussion is that of the influence of the mode of pumping and drilling on the physical appearance of the oil fields.

The oil fields of Lambton County are still producing oil but on a very small scale. The daily yield of individual wells is so small as to be measured in gallons rather than in parts of a barrel. With production so low the cost of pumping a well would exceed the value of the product were it not for the ingenious jerker rod and field wheel system that allows many wells to be pumped by one power source, today an electric motor, before that an internal combustion engine, and before that a steam engine. See Appendix D for

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1. Canadian News, Sept. 27, 1866, p. 196. I have found no descriptions of fishing tools during the 1860s. For descriptions from a later date and more information on fishing see Merle G. Decker, Cable Tool Fishing (n.p.; Water Well Journal Publishing Co., 1968), and Redwood, Petroleum, Volumes I, II.

descriptions of a system essentially unchanged for over eighty and perhaps as much as over one hundred years. The traditional story that the system was first introduced by J. H. Fairbank in 1865 is a story with which I wish to take issue.

Today the system is used because of the scarcity of oil; in the 1860s there was a scarcity of money and engines. J. H. Fairbank's Diary gives considerable insight into the 'scarcity' of steam engines. It was more than just a physical scarcity of steam engines. Engines were expensive, money was scarce, and many could not have afforded more than one engine if they were available. The problem was combatted by renting, sharing, and generally moving the engines about quite frequently. The engines were often broken and parts hard to come by.[1] A broken engine is about as useful as no engine. It was for these reasons that men wanted to get as much work as possible out of the engines present and in working order. But as this thesis tries to point out the engine shortage was even more acute earlier than 1865 and one might therefore expect to find

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1. Diary. Supporting evidence is found throughout.

steam engines being put to more than one use simultaneously at a date earlier than 1865. This is exactly what is found but Fairbank is not mentioned as one of the innovators.

The first reference to the use of one engine to pump more than one well comes four years before the normally accepted date for Fairbank's innovation. The reference is to two surface wells. "Both wells are worked by one steam engine of 6 horse power. They are very close together and the engine is situated between the two."[1] The following year the ingenious Mr. Comar is introduced and never heard of again.

> Mr. Comar employs a steam engine of about 6 horsepower for drilling and pumping. He gets but little oil -- not more than two barrels per day, but he is determined to persevere. He appears to be a most ingenious man, and has a variety of contrivances for economizing labor. Among others, he has fastened a shaft of wood to a long pit saw, the shaft in its turn being attached to a crank being turned by the engine. By this means a reciprocating motion is obtained, and a log placed under the saw is divided in a very short time. The engine thus saws its own wood to the great saving of its owner's muscle.[2]

Another good example of multiple use comes from the same year.

> Mr. Adams is now sinking a well, and has got 276 feet into the rock. The drilling is done

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1. <u>Globe</u>, Sept. 12, 1861.

2. <u>Globe</u>, Mar. 12, 1862.

> by steam; two walking beams are used -- one for pumping the water and oil out of the surface well and one for drilling.[1]

The three examples cited give three different ways in which one engine was used to do more than one job at a given time. Only one of these, the first, is similar in detail, although all are similar in spirit, to that of Fairbank's. In 1865, the year in which Fairbank is reputed to have instituted his system his name is not mentioned but there is considerable evidence that multiple use was accepted practice. One article mentioned three cases of wells being drilled adjoining to steam saw mills using the mill engine for drilling and pumping "ile".[2]

Messrs. Manning and Co., of Toronto, seemed bent on showing just how versatile a steam engine could be.

> The engine used in the refinery is to be employed in pumping the well for the present. Preparations are also being made for sinking a second well, one hundred feet south of the present one, and working both with a twenty horsepower engine.[3]

Captain Dick who has been introduced in connection with seedbagging was active in Oil Springs and one of the leaders in innovative practice.

> These wells are only 21 feet apart and worked up on an entirely new plan; both wells will be

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1. Canadian News, March 6, 1862, p. 151.

2. Canadian News, Nov. 16, 1865, p. 314.

3. Canadian News, Nov. 30, 1865, p. 341.

> drilled at the same time, and when the drilling is completed they will be pumped by one walking beam.[1]

In the same article the old Fairbanks well is mentioned but no unusual or new techniques are given unlike the case of the "Niles Company" which was planning to use a twenty-five horsepower engine to pump three wells. In the same month it was reported that "in several cases a single engine, of adequate power, is used for pumping two wells."[2]

All of the above leads to the conclusion that a development started in 1861 by men of very limited means confronted with an engine scarcity had by 1865 been seized upon by men of greater capital who also found in it an economical way to work wells. By 1866 it seems to have been common enough that no comment was needed when it was reported that

> Mr. J. Shaw, who suddenly found himself famous one day in 1862 is about to give the old spot another good "try", over again. He has a three inch pump and a boiler, much the largest in the diggings, which ought to be able to drive two or three pumps.[3]

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1. Canadian News, Dec. 7, 1865, p. 362.

2. Canadian News, Dec. 21, 1865, p. 391.

3. Observer, April 20, 1866. The article quoted is important in that it is J. not Hugh Nixon Shaw mentioned. This is merely one of the many pieces of evidence available to show that the Shaw gusher was not the work of Hugh Nixon Shaw but of John Shaw. One might interpret the reference to a large boiler as meaning that one boiler would power several engines as was done in refineries for safety reasons, but I believe that such an interpretation would be incorrect.

From the way in which the article is written it is evident that it is not Shaw's multiple pumping that is important but that he is going to use a different pump speed and stroke.

Two years later, 1868, when Enniskillen was again in one of its permanently temporary slumps a reporter from the Montreal Gazette was enthusiastically waxing eloquent.

> Oil City, once the scene of flowing wells which seemed exhaustless, is now a "deserted village;" and even Petrolia, the scene of more recent activity and good fortune, is but the ghost of its former self, and its silent neglected pumping stations rear their gaunt heads among the forest trees like veiled spectres, moaning Ichabod! Ichabod![1]

It is impossible to tell whether these "silent neglected pumping stations" were engine houses from which many wells were pumped by one engine or merely more conventional derricks hit at a gallop by a runaway reporter armed with a poetic license.[2] It is not an unimportant point because the introduction of the jerker rod and field wheel system for pumping many wells with one engine altered the physical appearance of the oil fields.

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1. Canadian News, Sept. 17, 1868, p. 179.

2. Canadian News, May 4, 1865, p. 279. One might also ask, without answering, whether the "moving beams" and "travelling ropes" of Oil Springs might refer to a multiple pumping system.

Early descriptions and photographs of the oil fields do not mention or show long lines of creaking jerker rods snaking across fields for miles, forcing walking beams to monotonously nod all day and through the night. One type of derrick shown is that combining well cover and engine house such as seen in the photo of the Pepper Well and picturesquely described in the following. "The derrick village ... is more like a colony of Dutch churches than anything else for a derrick is a roofed house with a tower at one end of it."[1] The picture of the Noble Wells with its two towers leads one to suspect that one engine pumped two wells.[2] The Noble Well is an impressive looking edifice perhaps tidied up a bit by the artist. A close look at the Pepper Well photo reveals less evenness in carpentry. One well description mentions nothing of fine workmanship, only crude functionalism. "The

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1. Canadian News, Aug. 17, 1865, p. 102.

2. The description accompanying the engraving confirms these suspicions. "John D. Noble...has done very much towards lessening the cost of the production of Crude Oil by consolidating the machinery and appliances thereof, under one building, for the purpose of pumping several wells with the same amount of labour and fuel which is ordinarily used in the pumping of one as will be seen in our illustration." See "Oil Wells of John D. Noble, Esq., at Petrolia, Ontario, Canada," Canadian Illustrated News, Feb. 11, 1871, p. 83. The illustration certainly does not clearly show what it purports to show.

derricks are built of pine scantling, in cone form, and each covers a distinct well."[1] The above and that to follow suggest that the engine need not be in the same building as the well.

> ... ten wells are in process of being drilled. The derrick raised over each is enclosed in frame work and boarding. Each is fifty or sixty feet high; fifteen or twenty feet wide at the base, six feet wide at the apex. They resemble clusters of windmill towers without the arms and sails, or dumpy church steeples without the churches.[2]

A derrick of this size would have no room for the engine inside. When pipes or sucker rods had to be drawn up the reason for the height becomes apparent as the men at the top of the derrick could handle and set them hanging from racks like hose drying in a fire station after a fire.

By the 1870s "windmill towers without arms and sails" and "dumpy church steeples without the churches" were becoming rarer, replaced by simple three pole tripods over a well site which is nothing more than an upright post on which, in obedience to its jerker rod, a walking beam nods monotonously. With a centralized

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1. Canadian News, May 25, 1865, p. 326.

2. Canadian News, June 14, 1866, p. 375.

pumping system and portable equipment for drilling wells and pulling pipes and pumps no more than a tripod, and not even that as tripods are easily moved, was needed at each well. The massive derrick serves no useful purpose once the well is drilled except for when the well must be pulled. The result was the disappearance of the massive but picturesque derrick. The derrick was for many the symbol of an exciting and unpredictable industry. The beginning of the passing away of the huge oil derrick was signaling that by the end of the 1860s considerable experimentation and innovation had taken place and a system of working had been developed and instituted that was to change very little.

CHAPTER III

CREATING A MARKETABLE PRODUCT

Preparing Canadian petroleum for commercial sale presented a number of chemical problems just as difficult to solve as the mechanical ones. In the first place Lambton crude had a particularly offensive odour. The "stinking stuff" was described as possessing "abominable odors"[1] and a "stink which rivalled a nest of polecats".[2] The undesirable odours were due, as is the case with many high sulphur Devonian crudes, to the presence of organic sulphur compounds having odours resembling onions and leeks.[3] During the 1860s a chemical explanation could not be given for the odours but they

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1. Observer, June 24, 1885.

2. These words are attributed to Thurston G. Hall who claimed he was going to take the "skunk" from Canadian petroleum. Hall is a rather fascinating character with an impressive but fraudulent scheme to use electricity and some rocks to purify and produce petroleum products. The best introduction to Hall and his schemes is in the Observer, Oct. 21, 1887. and Smith, S16 pp. 1-9.

3. Canadian News, May 4, 1865, p. 279. See also G. A. Purdy, Petroleum: Prehistoric to Petrochemicals (Vancouver: Copp Clark, 1957), p. 68. [Hereinafter referred to as Purdy, Petroleum].

were there nevertheless. Speaking of the oil regions of Lambton the Toronto Globe remarked that "the scene is a pleasant one to the eye" and then added "... but what is this that assails the nose? A compound of onions, and garlic, and antiquated eggs, most horrible to the unitiated, but to the oil digger sweet as the scent of new mown hay."[1] Customers tended to suffer from debility of the imagination and were less tolerant of the odour.

Bad smell meant lower prices and a restricted market. The Lambton product, unless sold under false pretences, was often bought only when low sulphur crudes were unavailable, and even then at a reduced price. Furthermore, carelessly barreled oil frequently contained additional impurities. It was an oft-repeated story that in early shipments, sticks, leaves, and twigs had been barreled along with the oil sent to England. One individual, interested in seeing that Canada and Canadian oil not be given a bad name, called in vain for the institution of government inspection "to prevent such wretched frauds as we understand

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1. Canadian News, Dec. 3, 1863, p. 426.

have recently been attempted."[1]

Lambton crude and refined were malodorous because of the presence of hydrogen sulphide[2] and other impurities many of which could be neither identified nor removed. The chemical knowledge and skills of the 1860s were inadequate for properly refining Lambton crude. The necessary plant facilities for proper refining were also lacking. A Globe editorial exclaimed that the oil producers were suffering because of the "lack of means of converting it into a burning fluid for use."[3] The "lack" was not due to a shortage in numbers of so-called refiners. Until the end of 1862

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1. "Necessity for a Government petroleum Inspector," Journal of the Board of Arts and Manufactures for Upper Canada, II (Sept., 1862), 261. [The Journal is hereinafter referred to as Manufactures for Upper Canada]. In July 1867 the word Ontario was substituted for Upper Canada.

2. Hydrogen sulphide was usually called "sulphurated hydrogen". Good evidence for the presence of hydrogen sulphide is seen in the statement that "all white-painted buildings were discolored with gas." The above is attributed to a resident of Wyoming during the 1860s and is to be found in Smith S20-5 in a quotation from a newspaper of March 1, 1917 dealing with the reminiscences of E. C. Rice.

3. Globe, Oct. 29, 1861. In the editorial it was gleefully reported that although Canada until recently had only two rock oil refineries it would have twelve to fifteen within a few weeks.

the producers seemed to be getting poorer and the refiners richer.[1] Such a seemingly lucrative business attracted many men who had neither the chemical knowledge nor the capital to produce a product acceptable by the standards of the day.

Although it will not be emphasized in this thesis those distillers and/or refiners pursuing the requisite skills and material resources to produce a consistently good product were not, so to speak, operating in a vacuum. As regards the technology of production, various problems faced in the petroleum industry had been confronted and to some extent solved or at least worked on in related but earlier work by men such as Seligue, Young, and Gesner, and others who concerned themselves with the problem of purifying coal gas, particularly removing sulphur.

As various petroleum products were introduced there were standards of comparison in pre-existing products which the petroleum interests hoped to displace by showing that the new petroleum products were better.

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1. Hamilton Times, Sept. 1. 1865. [Hereinafter referred to as Times].

The major nineteenth-century petroleum product was an illuminant, variously called coal oil, kerosene, or trade names such as Victoria Oil. The comparison of petroleum derived products with non-petroleum based products, the posting of claims and counterclaims, an eventual change of view, and share in the market is seen in the activities of Messrs. Parson Brothers of Toronto. A short history of their involvement in the illuminating fluid business is given in the Globe, Feb. 7, 1861, but a better indication of the shift is revealed in their newspaper advertisements.

By early 1859 it is clear that Messrs. Parson Brothers were beginning to feel the pinch, they claimed the stench, of a new product and inserted an advertisement in the Toronto Leader for the benefit of their friends and customers.

A CARD TO CONSUMERS OF COAL OIL

> The subscribers have been for some time annoyed with numerous complaints from the consumers of coal oil, of having purchased a disgustingly nauseous compound, which interested parties have palmed off for coal oil. We should simply say once and for all that this worthless and offensive stuff has not been purchased from us. We take this method at the request of many of our customers who have been deceived in this way, to caution our friends to see that those whom they send for Coal Oil find the right place. In consequence of the enormous demand we have sometimes been obliged to curtail the required quantity, but our oil can always be relied upon, and our arrangements are

> such that we trust very soon to be no longer troubled by short supply.[1]

The warning was supplemented by various other public service announcements -- advertisements -- regarding the receipt of Coal Oil "entirely free from unpleasant smell"[2] and announcing that they could supply 1000 gallons per week.[3] It is apparent that neither the citizens or Toronto nor the oleaginous interests were heeding the polite blandishments of Messrs. Parson who, in order to protect the public, found it necessary to be harsher and less polite. The previously anonymous "disgustingly nauseous compound" was now publicly identified and accused of its crimes.

> TO CONSUMERS AND DEALERS IN COAL OIL
>
> The justly celebrated reputation of coal oil as a cheap and brilliant light has induced parties with whose interests it has interfered to sell various disagreeable compounds under the name of coal oil, with the evident intention of bringing the genuine article into disrepute. <u>Disgustingly nauseous Petroleum</u> or <u>Earth Oils</u> throwing off <u>pernicious gases</u>, most <u>detrimental to health</u>, and comfort are now being offered for sale and also being labelled as Coal Oil. The subscribers would caution the public against these <u>barefaced imposters</u>, and would notify that they are now

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1. <u>Leader</u>, April 18, 1859.

2. <u>Leader</u>, May 3, 1859.

3. <u>Leader</u>, July 2, 1859.

> prepared to fill all orders with a beautiful article of pure coal oil at reduced prices. Be sure to get Excelsior Coal Oil.[1]

But alas and fortunately for the hero petroleum, alias rock oil, although the nineteenth century was filled with cruel villains it was also one in which the weak and helpless were often able to find selfless supporters and proectors who ushered them into polite society. Rock oil[2] found such a protector of maligned innocents in the person of a man of the cloth, the Reverend Mr. John Gray of Orillia. Orillia was not quite the centre of polite society but the Reverend Gray was a good character witness, defended the honour of Rock Oil and took a dignified poke at Messrs. Parson.

PETROLEUM OR COAL OIL

> H. Piper and Brothers beg leave to draw attention of the public to the subjoined certificate (unsolicited) from the Rev. Mr. John Gray, of Orillia ...
> Certificate -- This is to certify that for nearly two months I have used coal oil made from the Enniskillen petroleum, and have during that time, carefully compared it with oil purchased from Parsons of Toronto, that such comparison has lead me to conclude, that in regard to purity of appearance, comparative freedom from offensive smell, the quality of the light which it gives, and its effect upon the eyesight, the oil from Enniskillen petroleum is superior to that furnished by Parsons.

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1. Globe, Sept. 21, 1859. My italics.

2. Also known as Enniskillen petroleum, petroleum, earth oil or just that stinking oleaginous stuff.

John Gray, Presbyterian minister from Orillia and East Oro, the Manse, Orillia.1

If the above, an unsolicited testimonial from a man of God, was not enough, and if he seemed to hedge a bit by speaking only of "comparative freedom from offensive smell" then one had only to remember that even before being taken under the wing of Rev. Gray, Prof. Crofts of the University had rendered Lambton rock oil fit for polite company by removing its "unmistakeable effluvium."[2]

The war raged on for some time but eventually Messrs. Parson softened their attitude towards Rock Oil and forgave his past transgressions. The Rev. Gray probably had nothing to do with the change in attitude, petroleum illuminants with all of their faults were a better buy than any other product. As indicated in the history to be found in the Globe, Feb. 7, 1861, they first turned to Pennsylvania crude oil and then to Canadian.

We see by the Globe of Wednesday that Messrs. Parson Bros., extensive coal oil importers, have

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1. Leader, Sept. 30, 1859.

2. On May 31, 1859 the Toronto Leader announced that the odour had been eliminated from Enniskillen Oil. In the Smith Collection the following newspaper article of June 3, 1859 is found. "Prof. Crofts has succeeded in deodorizing the natural oil found in the County of Lambton. This was all that was required before being placed on the market. Mr. Williams has already secured some 20,000 gallons in its crude state. We expect it will soon be on sale, its illuminating qualities are unequalled, but it had an unmistakable effluvium." See also Canadian News, Feb. 1, 1860, p. 38.

> determined to establish another refinery at Toronto, and will use the Canadian as well as the Pennsylvania oils in this establishment. This is encouraging, and ought to induce Canadians to patronize home manufactures, especially when of a superior kind.[1]

Price was not the only factor to consider when buying illuminants; safety was important. Camphene, a lighting fluid composed of turpentine and alcohol, was, during the 1850s, very common and economical. Due to its extreme volatility camphene was extremely dangerous. Many an advertiser found it necessary to point out that his product was not camphene nor was it as dangerous as camphene even though his competitors' Pennsylvania product might be.[2]

Throughout the nineteenth century the most important

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1. Observer, May 3, 1861.

2. See for example the advertisement of The Canadian Oil Company, Leader, Mar. 29, 1861, in which it was claimed that "the large majority of rock oils, imported from the U.S.A. are beyond question explosive. Many of them moreso than Camphene." In order to prove the safety of their product the Canadian Oil Company suggested a "test to ascertain the explosive qualities of oils. Pour, say a teaspoonful of oil upon a board and place a lighted match in contact with it. If the oil is explosive it will instantly ignite like camphene; if non-explosive it will only ignite after the flame has heated the oil."

single use of petroleum was as an illuminant and its 'success' in this role was, above all else, a tribute or insult to the skill of the distiller and refiner. The preparation of a socially acceptable safe illuminant from crude petroleum involved two distinct but related processes: distillation and refining. Distillation was the simpler and less complex of the two, having as its purpose the production of a liquid lacking the lighter and more volatile fractions as well as the heavier and more viscous fractions or residue. Distilling was a mere one step preparatory process whereas refining involved a number of steps and had as its aim the production of various finished products ready for consumption. Needless to say, deodorization was one of the most important and most baffling steps in refining. Both operations, viz. distilling and refining, could be performed in the same plant but often were not. It seems that many customers did not understand the difference between refined and distilled and some sharp dealers sold distilled for the price of refined, much to the chagrin of their customers who soon joined the ranks of those who had nothing good to say about petroleum.

As with much of the early growth of the oil industry the development of the refining and distillation facilities

was rather haphazard. Out of this chaotic and apparently directionless growth an industry emerged. Many simply did not know how to react to the prospect of the growth of a new industry. A prime example was the Sarnia Council which when asked to grant permission for a Mr. Forsyth to erect a refinery within the town limits was not quite sure what it should do. The Council was uncertain whether or not it had the power to grant or refuse such a petition, but decided in Mr. Forsyth's favour because they did not like to discourage the growth of their town.[1] Not all seemed as perplexed or as willing. One year later George Stevenson was complaining that "for five different companies I have tried to purchase sites for oil refineries, and in no case have I been successful." Neither the Grand Trunk not the Indians on the Indian Reservation were sure how valuable bay or river frontage was and were in no hurry to sell.[2] Not all of the inaction was due to confusion or opportunism; there was a steady growth of opposition to refiners and their refineries. No one seemed to oppose refineries

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1. Observer, Feb. 28, 1862.

2. Observer, Mar. 30, 1863.

as long as they were in someone else's neighbourhood. By 1871 Sarnia Council seemed to have emerged from their fog of indifference or perhaps were choking in the fumes and refused to allow the Dominion of Canada Oil Refining Company to erect a refinery in Sarnia as "one refinery at the north end is enough without having another one at the south end."[1] Two years earlier the hostility towards refinery odours had reached the courts where it was decided that the unpleasantries were just a part of modern life. Refineries, though a nuisance, were a necessary nuisance and would stay.[2]

Petroleum wells and refineries were the source of very visible and obnoxious industrial pollutants. There was no desire to annihilate a struggling young industry but, on the other hand, there were others to consider and no one wanted Canada to reproduce the grimy smoke-filled cities and polluted waters of industrial England. The problem is well illustrated by an incident in Hamilton.

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1. Observer, Feb. 17, 1871. The Company, which proved to be a colossal 'bust' and a fraud, solved its problem by buying Indian Reservation land, a continuing trend in the Sarnia region as Chemical Valley grows larger and the Reservation smaller.

2. Observer, March 5, 1869. This attitude remains substantially unchanged.

> We have been informed that the refuse from the coal oil refineries, which is emptied into the bay and lake is having a very deleterious effect upon the fisheries at the beach. It is said that the water on certain mornings is covered for a considerable distance with oil, and the effect has been to drive away the fish from the beach. The subject is not without difficulty. In the infancy of the coal oil business it would be inexpedient to place restrictions on the operations of refineries, but at the same time it would be disastrous to the fishing interest if the fish are to be driven from the beach by the noxious effluvia arising from coal oil.[1]

Little attention was paid to such appeals.

> At one time the Oil Springs neighbourhood promised to become a little manufacturing city, and the smoke from its numerous chimneys might have put some people in mind of what they had seen at "home".2

The "home" being referred to was no doubt the grimy, smoke-filled industrial cities of England and elsewhere from which many had fled to Canada.[3]

There was a good reason why Oil Springs and a number of other areas were beginning to look like home. Perhaps the poltiicians did not know how to react to this new source of wealth from the bowels of the earth but others did. The drillers, distillers, and refiners were very

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1. Canadian News, July 3, 1862, p. 11. Based on a report from the Hamilton Spectator. The fish lost; the effluent society won.

2. Times, Sept. 1, 1865.

3. It is unlikely that the desire to find relatively unpolluted air was a major reason for coming to Canada. Many came to escape grinding recurrent cycles of poverty and unemployment that they were caught in: a spiritual more than a physical pollutant.

busy. Those who had even some of their senses about them knew that something was ado. "The atmosphere, especially on foggy days was heavy with the perfume of crude oil and all white-painted buildings were discolored with gas."[1] Many times Allan Duncan had good reason to write in his journal that "there was a strong smell today from the refineries here."[2]

The building boom for refineries and distilleries began in early to mid 1861 and by 1862 there was no question that it was indeed a boom. The data to paint an exact picture of the growth has been lost, perhaps irretrievably, but there is enough to sketch a general outline. The spring of 1861 witnessed the blossoming of many plans for refineries, not all of which materialized. By March it was announced that Mooretown, a St. Clair River port of 250 people, had a "refinery" and "a magnificent road leading direct from the wells thither."[3] The so-called road was anything but magnificent and from the lack of further reports I suspect that if the

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1. Smith, S20-5.

2. Diary of Allan Duncan, Mar. 11, 1869, as quoted in Smith, S20-3. The diary is to the best of my knowledge unpublished.

3. Observer, Mar. 29, 1861.

refinery existed at all it was a crude distillery. The following month the London Free Press announced that six stills had passed through London on their way to Enniskillen for the new refinery being established there.[1] It is possible that these were destined for the Petrolia works of the Petrolia Oil Refining Company which in early May was to have been in operation by the first of June of the same year.[2] Delays, almost invariably due to a shortage of crucial parts and equipment, were a way of life in Enniskillen and two and a half months after the projected opening date the refinery still lacked "a competent person to take charge." The said "competent person" was to come from Boston[3] and arrived before the end of September, by which time the refinery was "turning out an excellent article."[4] At the same time, it was noted that

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1. Free Press, April 18, 1861.

2. Observer, May 3, 1861. It was also announced that Parson Bros. of Toronto were building another refinery at Toronto in which Canadian oils as well as Pennsylvania oils would be worked.

3. Observer, Aug. 16, 1861.

4. Leader, Oct. 1, 1861. Several weeks later the Observer, Oct. 18, 1861, described their product as "an article of burning oil equal to anything we have ever seen or used" this having been determined "by actual experiment."

> many other refineries are now being built, owing, no doubt, to the fact that the business of refining is found to be immensely profitable. The oil is purchased at about three to five cents per gallon. It is refined at a trifling cost, and is retailed at from 60 to 80¢ per gallon. So far the refiners have had all the profits.[1]

A *Globe* editorial exhorted refiners and would-be refiners to correct "the lack of the means of converting it [crude petroleum] into a burning fluid fit for use." The same editorial made it clear that this problem was at least being faced even though not yet solved for, while lamenting that "there have been until lately only two refineries in Canada, both near the city of Hamilton," it was announced that "12 to 15 refineries will be in operation in a few weeks."[2] As is to be expected from perpetually over-optimistic newspaper and refiners' reports

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1. *Leader*, Oct. 1, 1861.

2. *Globe*, Oct. 29, 1861. It is not known how late "lately" is; in the same article it was mentioned that 2 refineries were in operation in Toronto with a third to be started soon. The refineries in Enniskillen, Port Credit and London were nearly complete and those in Sarnia, Komaka, Woodstock, and Welland either operating or under construction. There were also 2 in Lower Canada, projected or begun. Essentially the same information as in the *Globe* of Oct. 29, 1861 is given without acknowledgment in the *Canadian News*, Dec. 12, 1861, p. 277, in an article making it clear that, in their opinion, refineries were the domain of those with capital -- capital to risk. "Considerable capital, say from $6,000 to $10,000, is required to start works on a scale large enough to be profitable, and then there is the risk of fire, which will always make the business a hazardous one."

the opening of refineries did not quite happen as fast as predicted. The Woodstock Oil Refinery, "nearly completed" on October 18, 1861,[1] to be "in operation in a few weeks" on October 29, 1861,[2] was by November 11, 1861 "expected to be completed in the course of four weeks at the farthest."[3]

Sure of its direction but not of its pace the refinery construction boom charged, some might say wandered and wallowed, into 1862. It is difficult to say just how much progress was made in 1861; there was some since by early January 1862 Messrs. O'Reilly and Savigny had advanced far enough to have had their uninsured refinery in operation and allowed gas to escape and come into contact with a lamp. The resulting explosion and fire left them with half a refinery which was to be rebuilt "in the course of a few days."[4]

Spring in Enniskillen brought seemingly unlimited quantities of mud and the reappearance of newspapermen.

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1. Observer, Oct. 18, 1861.

2. Globe, Oct. 29, 1861.

3. Globe, Nov. 11, 1861.

4. Globe, Jan. 11, 1862. A few days was the usual time given as necessary to rebuild a burned and/or exploded refinery. Often a few days would last more than a month and some of the few days have yet to expire. Newspapermen and refiners often allowed their desires to interfere with informed judgment.

Just how many refineries there were in the oil regions is not clear but the pace of construction was hectic. In the issue of March 6, 1862, probably reflecting the situation in Canada in late January or early to mid February, the Canadian News announced that there would soon be four refineries at Black Creek.[1] On March 10, 1862 it was reported that Oil Springs had six refineries[2] and yet by March 18, 1862 this number is supposed to have increased to fifteen.[3] It is doubtful that nine refineries were built or opened in 8 days. The reason for the apparently rapid rate of construction is that in the report of March 10 it is clearly the "village of Oil Springs" with its "population of 600, 4 stores, 2 taverns, 6 oil refineries, 4 cooper's shops ..." that is being referred to. In the report of March 18, although the author again appears to be referring to the village of Oil Springs, his refinery figures probably refer to the general vicinity in which oil was to be found, a vicinity frequently referred to as the oil springs or the diggings. This interpretation is buttressed by subsequent reports.

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1. Canadian News, Mar. 6, 1862, p. 151.

2. Spectator, Mar. 10, 1862. The figure of six is given in Canadian News, April 10, 1862, p. 231.

3. Leader, Mar. 18, 1862.

It is known that by May 1862 Mr. Hugh Nixon Shaw had completed the refinery he had talked about in September 1861 because it burned and three of the stills were damaged. In reporting this calamity the Oil Springs Chronicle noted that "we have one refinery less in operation to report. The number now here, completed, operating and ready for operation is six, not including the one at Petrolia."[1] The reports for July also indicate that fifteen is a little high for the number of refineries at Oil Springs. A July 4, 1862 report "concerning the oil region" speaks of "9 refineries here on various scales of magnitude."[2] Three weeks later it was reported that there were "ten refineries in this immediate locality and several others within a compass of twenty miles."[3] Unfortunately meanings of terms such as "immediate locality" and "several others" are not known. The figure of fifteen oil refineries in the oil springs

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1. Oil Springs Chronicle as quoted in Observer, May 20, 1982. The Canadian News, June 19, 1862, p. 391, based on a dispatch from a correspondent of the Hamilton Times, says of Oil Springs: "there are 6 or 7 refineries here, and one belonging to a Boston Company at Petrolia."

2. Times, July 4, 1862.

3. Observer, July 24, 1862. The Canadian News, Aug. 7, 1862, p. 86, replying on a correspondent from Enniskillen reports nine refineries, apparently for Oil Springs. These were on various scales of magnitude and he expected many more soon. One of the reasons for the increase was that "in most cities and towns a prejudice exists against oil refineries, which is here totally unknown except by report."

region included Wyoming. It is traditionally held that in 1862 Wyoming had six refineries.[1] An official tabulation, if anything is to be called an official tabulation, of the number of refineries in Ontario in 1862 credits Wyoming having only one.[2] The source for the above is the Toronto Review of Trade for 1862 in which Wyoming is given one, Petrolia one, Oil Springs eleven and Sarnia two refineries, giving a total of fifteen refineries for the oil regions if Sarnia is included, thirteen otherwise. The editor was not sure about Wyoming but guessed it to have one refinery of five stills. The figure for Wyoming is close to six and it is not inconceivable that a visitor or reporter regarded each still as a refinery rather than seeing a refinery as having a group of stills.

While describing the growth of refining capacity in the oil fields of Canada West it should not be forgotten that many distilled and then shipped the "oil as it comes from the still without further treatment."[3]

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1. See Smith, S20-1, 1967, and Smith, S20-19, circa 1960.

2. "The Petroleum Trade," Annual Report of the Board of Trade, With a Review of the Commerce of Toronto for 1862, (Toronto: E. Wiman, 1863), 34-37. [Hereinafter referred to as "Petroleum," Board of Trade, 1862].

3. Canadian News, Oct. 9, 1862, p. 236.

> Since refined oil has advanced so much in price everybody has made up his mind to build a refinery, or at least to put up a still, and the probability is that one hundred stills will be in operation in this place in less than two months.[1]

The extent of the growth of distilling capacity is seen in the Oil Springs Chronicle statement that

> it is estimated, from reliable data, that it will require upwards of 4,000 barrels of crude oil to charge a single time all the stills now in Canada.[2]

The above refers to a time when refining capacity was 2,400 barrels per week[3] meaning that to charge all refineries once would take much less than 2,400 barrels.

Much money had been invested in building the refining and distilling capacity to the point it reached by the end of 1862 and few realized at the time that the peak had been reached and a two year depression was to follow. The cessation of the flowing wells early in 1863 forced many refineries to close.[4] Many refiners did not have the resources to weather prolonged inactivity and

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1. Canadian News, Jan. 15, 1863, p. 36, from the Oil Springs Chronicle, no date given but it is probably late December.

2. Canadian News, Feb. 12, 1863, p. 108.

3. "Petroleum," Board of Trade, 1862, p. 36.

4. Canadian News, April 16, 1863, p. 244.

were wiped out. By 1865 there were "but 2 or 3 refineries ... in all the Oil Springs neighbourhood."[1] At the end of the same year there was but one in Oil Springs.[2] Fate was most particularly unkind to Oil Springs as the earth was to give of her oil more freely at Petrolia where there was a railroad. Oil Springs was once again isolated as the plank road to Petrolia, now a useless link, fell into disrepair and was "all but impassable." Symbolic of capitulation and misfortune was the closing of the last refinery.

> ... there has been only one refinery at work there for many months past, and that suspended operations because its stills were worn out, and the proprietor did not feel justified, under the then prospects of business to put in new ones.[3]

The stills had worn out in Oil Springs and so too had the ground but the rest of Enniskillen had oil and where there was oil there was life.

During 1865 the depressed times became less so and an era was ushered in characterized more by a few large producers than by many smaller although the small had by no means disappeared. Amongst the refiners and distillers in the first half of the 1860s there was a high rate of financial failure. It is also true that Petrolia,

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1. Times, Sept. 1, 1865. The Observer, Dec. 8, 1865, sounds as if there is only one refinery in Petrolia.

2. Canadian News, Dec. 28, 1865, p. 407.

3. Canadian News, July 2, 1868, p. 7.

Wyoming, and Oil Springs, i.e. the villages in the heart of the oil regions, were not the major refining centres of Ontario crude as this operation was being carried on in the larger urban centres both in and out of Canada;[1] the figures in the Monetary Times clearly attest to the continuation of this trend.[2]

Refining and distilling represent two traditions in two different senses. First, as clearly indicated previously, refining and distilling are two distinct operations. Second, during the 1860s there grew up two traditions as regards size: the large and the small scale with the latter predominating in terms of number of companies involved. Although the small tended to be the most financially unstable and vulnerable there were a few rather grand and glorious failures and frauds amongst the large outfits. In general, those who managed to travel from the ranks of small scale producers and refiners to the large scale tended not to have fewer financial difficulties and setbacks early in their careers they just appeared to be more resilient. Some of the earliest steps towards commercial exploitation

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1. Observer, July 20, 1871.

2. The Monetary Times is the best single source of information of this type.

were taken by men unable to survive the financial and technological struggles met in establishing a new industry.

Much of what little commercial exploitation of Canada West petroleum that took place in the early 1850s is shrouded in mystery. Little is known about the equipment used throughout the 1850s. It is known that in 1854, two years after their initial application, The International Mining and Manufacturing Co. were granted a charter.[1] The Tripp brothers, Charles and Henry, seemed to be the most dynamic of the partners. The following year at the Paris Exhibition of 1855 the company was awarded an honourable mention for its asphaltum.[2] The raw material for the asphaltum came from the "Gum Beds" of Enniskillen, "large deposits of the dried residuum of oil, from which all the volatile parts have evaporated and escaped."[3] Charles Tripp seems to have done most of the technical work and could have produced the asphaltum exhibited in Paris

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1. The charter is given in Appendix D.

2. J. C. Taché, Canada at the Universal Exhibition of 1855 (Toronto: John Lovell, 1856), p. 372. The award was said to be made to "Hamilton International Company, for asphalt."

3. Observer, Jan. 24, 1863.

using very crude equipment -- a simple distillation apparatus to drive off but not to save the remaining more volatile components, and a crude screen or filter to rid the asphaltum of mechanically separable impurities such as twigs, leaves, and gravel. He then might have added a binding agent such as sand or gravel. There is good, although far from conclusive evidence that Charles Tripp wanted to produce a lighting fluid from liquid petroleum.[1] Whatever his intention, it is quite clear that he did not succeed and by late 1858 or 1859 a Hamilton entrepreneur James Miller Williams was in control[2] and working Tripp's oil lands.

In August of 1858 liquid petroleum (mineral oil) from Enniskillen was being used to make a lamp oil with the preparation (refining) being done by Williams in Hamilton. It is not clear whether any preparation, possibly distilling, was being done in Enniskillen.[3] But by December Williams was distilling, perhaps refining in Enniskillen.

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1. Free Press, Jan. 27, 1859.

2. Free Press, Jan. 27, 1859. Williams was not one of the original members of the Company and I do not know exactly when he became involved.

3. Free Press, Aug. 26, 1858. The article mentions burning oil and it is clear that it is not a distilled but a crude oil being burned. It is also clear that the oil was from a liquid.

> We learn that the proprietor of the land in which the Springs are situated, has erected a suitable building thereon, and is now manufacturing by distillation, a beautiful burning oil from the material which abounds in the region. The article described is of a most desirable quality, and its illumination properties are so great that an ordinary sized lamp, giving a light of 6 to 8 candles, can be kept burning at the rate of one quarter cent per hour, reckoning the oil at $1.50 per gallon. We think some of our merchants ought to procure a supply, for at that rate it must be the most economical light in existence.1

By mid 1858 Williams had clearly been working with a liquid oil as his raw material, but an important news article in 1859 indicates that although working with wells and naturally available liquid oil he felt that the future lay with the production of a liquid from a solid as had been done with coal.

> ... several wells of considerable depth have been dug, the effect of which has been to collect large quantities of natural oil without the intervention of any process such as distillation. It is not intended to rely, however, upon that source of supply, but works are in the course of erection for treating the oil earth after a fashion somewhat similar to that in which coal is treated .... There can be no doubt that a far greater yield per centum of oil will be obtained from the earth than from the coal, and that consequently, it will be sold at a price much cheaper than it can now be obtained for.2

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1. Free Press, Dec. 30, 1858.

2. Free Press, Jan. 27, 1859. In the same article the problems of deodorization are mentioned. That Williams should put faith in distilling earth is not surprising. Recall that Young started with petroleum but it ran out and he turned to the distillation of coal; Gesner worked from coal or coal-like material as did many others. In Collingwood oils were being made from the destructive distillation of shales.

By August of 1859 Williams seems to have placed his faith in and money on liquid oil from wells as he was pumping from a 30 foot well and working the oil on the site. Unfortunately, the historical account is very brief and confusing. After pumping, the oil "is then subject to sufficient heat to cause the finer oil to evaporate, by which means, and a distilling apparatus, it is prepared for the market. The waste in passing through this process was about 20 per cent."[1] Just how this process worked is not clear. Perhaps the crude was initially heated in open containers to drive off the light fractions and the remainder distilled, but this would have been very dangerous. It is possible that the oil was distilled and then, in what the reporter calls the "distilling apparatus," actually further purified but this too is doubtful because Williams already had equipment in Hamilton for the final process. Probably all that happened in Enniskillen was a single distillation and the product was separated into various fractions or cuts. This interpretation is in harmony with the fact that in 1858 the product was conveyed to Hamilton for processing, apparently for

1. Free Press, Aug. 5, 1859.

preliminary (distilling) and definitely for final (refining) processing and this was still being done in early 1860.

Refineries and distilleries had a marked propensity to burn. In April 1860 a "destructive fire" occurred in Hamilton at "the Coal or Earth Oil Manufactory Establishment of J. M. Williams ... where the raw earth oil, obtained in the neighbourhood of the township of Enniskillen is rectified and prepared for use ...."[1] Two and a half months later Williams had another fire this time at Enniskillen when the "still house, for the preparation of engine oil, was destroyed by fire."[2] Were it merely mentioned that a still house had burned one might wonder if it actually had been a refinery but the fact that it was used "for the preparation of engine oil" indicates that the reporter was not being careless with his use of technical terms. Engine oil at that time was not deodorized or clarified but was just one of the heavier distilled fractions without treatment beyond distillation. Shortly after the above

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1. <u>Observer</u>, April 6, 1860, based on <u>Hamilton Times</u>. This was the second fire for Williams in two weeks. Rectification refers to refining not mere distillation

2. <u>Observer</u>, June 22, 1860.

fire an article on the general state of the nascent oil industry and Williams' work in particular made it clear that "roasting" was a thing of the past. It mentions that when Williams came into possession of the Gum Beds he

> thought that there might be oil obtained from the substance that lay on the surface. He therefore prepared retorts and began roasting the soil for the purpose of evaporating the oil from it. In digging up the soil for this purpose he found that the oil ran into the sides of the hole. This led him to further digging, and now ... he has a well in full operation which supplies as much oil as he can want ... pumping the oil into a still on the ground in which it receives its first refining process.[1]

It should now be clearly established that as early as 1858 petroleum was being distilled although not necessarily refined[2] in Enniskillen and that this distillation was not only of a liquid but also of a solid with the former process having completely displaced the latter by 1860.

The nature of the equipment has not been established. However, the nature of the processes involved provides some insight into the equipment. There were two processes

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1. <u>Leader</u>, June 30, 1860.

2. That it was being refined in Enniskillen is extremely doubtful.

at various times: the roasting and distilling of a solid and the distillation of a liquid. The equipment for both is essentially the same. Given the extreme difficulty of transporting heavy equipment into the oil fields and the experimental nature of Williams' work it is safe to assume that the equipment would be on a rather small scale and simple.[1] Just how simple and how primitive is suggested by the comments of the *Hamilton Times* on the oil industry prior to 1863.

> During this period, "Establishments" of all capacities, from one or two barrels up to 100 per day were fitted up. Oil stills and their whole apparatus were in demand, to the great profit of those who furnished the "plant"; that is, if they were well paid for it. Everyone who could obtain, either for cash or on credit, such a thing as a small sized *potash kettle*, with another inverted and cemented over it, became a distiller. There were many "distillers", it must be remembered, who having neither the means nor the skill to attempt deodorizing, were content merely to distill the oil to clearness, selling for what they could to refineries, who alone possessed the appliances requisite for the finishing process.[2]

Many of these plants would be on a very small scale and lack of money was not the only reason that distilleries were often made on a rather small scale.

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1. The speed, often a matter of days or weeks, with which early distilleries were repaired and made fully operational after serious fires suggest small scale and simple equipment. It is not to be explained merely by saying that the fires were small and of no consequence. One must also make allowances for errors of judgment.

2. *Times*, Sept. 1, 1865. My italics.

" ... owing to the danger of fire, it is not desirable to build very large works."[1]

A refinery in Bothwell, built in 1862 or earlier, and described as "small", contained "two stills, each of a capacity of five barrels, and will turn out from 25 to 30 barrels of refined oil per week."[2] If the proprietor, Mr. Brake, was intent only upon producing an illuminant, as it seems he was, then his product yield would have been fifty to sixty per cent of crude which would mean that on a six day week his stills were charged daily. If, on the other hand, Mr. Brake was recovering all of the possible products his production figures would indicate that he was charging, i.e. filling, his stills every two days. Charging every two days is close to the 41 hours given by Parson Brothers for a test refining of 17 barrels of crude Manitoulin Island petroleum.[3] Given the increased distilling time with the increase in still size Mr. Brake probably charged his stills every day rather than every two days. The difference in size between the large and small

1. Canadian News, Dec. 12, 1861, p. 277.

2. Canadian News, Dec. 22, 1864, p. 388.

3. Canadian News, Jan. 16, 1866, p. 36.

refineries was not as marked as some might expect. Brake's 25 to 30 barrel per week refinery was regarded as small but in late 1865 Parsons were the largest in Toronto with 240 barrels per week production capacity.[1]

The distilling equipment was very simple. Something as simple as two potash kettles should be taken as no exaggeration as they would do the job for liquid or earth.[2] All that one would need to do is attach a "worm" or condenser to the top kettle. Attaching the condenser would be easy because although cast iron cannot be welded it is easy to drill. Holes could be drilled or cast into the kettle and to these a flange and worm bolted. Cementing the two kettles together would be easy using the recipe or one similar to that published in the <u>Journal of the Board of Arts and Manufactures for Upper Canada</u>.[3]

The simplicity of the distilling equipment is seen

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1. <u>Canadian News</u>, Feb. 8, 1866, p. 86. Larger plants were often rumoured but just failed to materialize, see <u>Canadian News</u>, Nov. 9, 1865, p. 312.

2. It would work with earth as this was oil-soaked earth and merely an extractive or separatory distillation was involved with various fractions leaving at their volatalization temperatures. This is not a process of destructive distillation although some unintentional cracking would take place.

3. "Cement for Joints of Petroleum Stills," <u>Manufactures for Upper Canada</u>, II (Oct., 1862), 317.

in the apparatus of Hugh Nixon Shaw. Shaw, before his death in 1863, had designed and put in use what was then regarded as the most sophisticated and advanced distilling equipment in the oil regions. Shaw is representative of the small operator in that he was a distiller[1] working on a small scale and when he died left his family little or nothing in the way of financial gain to show for his efforts. He was atypical in that he was regarded as the best or a leader in his field and we know something about his stills.

> The Montreal Co. are about to start 6 of Mr. Hugh Shaw's patent stills; the latter is reported being able to refine about 8 barrels per day. Messrs. Liddell and Sherman and Mr. S. H. Smith have each one of Hugh Shaw's patent refiners, which distil about two barrels each day. The oil is not deodorized but merely distilled, and Mr. Shaw claims that he is able by once running the vapor through the worm more completely to rid it of all explosive elements than by other processes employed. His stills are like two sugar kettles placed upon one another, forming together like an iron globe. From the top or rather that portion of the globe which is made to be a top, rises a pipe connected with the worm. Before the vapour can enter this pipe from the retort, it has to pass through two wire meshes; the first of iron and the second of brass, both very fine, but the latter much the finer of the two. By this means Mr. Shaw contends he retains many impurities in the retort, which otherwise would be carried into the oil. The vapour when condensed passes in the ordinary way into the vessels prepared for its reception, but the benzole is separated from it by an ingenious

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1. There are those who claimed that he drilled the first gusher. I see no evidence for such a claim.

> contrivance. Through the upper surface of the pipe which conveys the distilled oil from the worm to the vessel prepared for its reception, a hole is cut into which a second pipe is let at right angles and carried through the roof into the open air. Out of this second pipe the oil cannot pass -- it falls into the cistern through the hole below -- but the benzole being lighter than the atmosphere, rises in the pipe, and gains the outside. By this method 50% of the illuminating oil is gained; but the remaining 50% is all lost.
> The waste is by no means necessary, as by observing certain conditions 93 parts of every hundred may be turned to account. When this is done Mr. Shaw proves he gains 2% benzole, 22% of spirits of petroleum (another name for the benzole which he saves, and which may be used for all purposes to which turpentine is applied) 50% of the illuminating oil, 20% of lubricating oil, and the refuse, the remaining 6% may be converted into asphaltum, or be made to render up the Mauve, Majenta, and azure dyes it contains.[1]

The description, as far as it goes, is clear enough and needs little further comment. The vent pipe (the "second pipe") is a common feature in distilleries during the 1860s and the nature of the product lost through it would depend on the extent to which the vapours had cooled and condensed prior to reaching that point. The vapours were cooled by water cooling, the only workable solution. The product yield of 50% is

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1. Globe, Mar. 12, 1862. The Observer, May 20, 1862, mentions the destruction by fire of the Shaw refinery; only three of the stills were damaged.

that for the pursuit of a single product with the increased yield coming with no increase in illuminating oil products. Greater yield is simply the result of retaining that which was previously wasted. Although no details are given explicitly, the increased yields would be the result of two separate actions. The first is simply cleaning out and keeping rather than cleaning out and throwing out the refuse and heavy (lubricating) oil left in the bottom of the still after distillation. The second step would be one of the following two alternatives. Effectively increasing the cooling capacity and closing off the vent pipe would cause the benzole and spirits of petroleum to condense with the illuminating oil, a solution which although workable would necessitate a second distillation to produce a safe illuminant. It is therefore likely that Shaw would have retained the second pipe. But instead of allowing its contents free access to the atmosphere the vent pipt would lead to a condenser which would produce liquid benzole and spirits of petroleum. Another reason for believing that Shaw would have used the latter of these two alternatives was his concern with getting the explosive (volatile) elements out of the illuminating oil.

As regards capacity the description of the Shaw

apparatus is helpful but not unambiguous. The apparatus is not a continuous charge one and would have to be cleaned and given time to cool before recharging lest a fire or explosion be the result. It is safe to assume one run per day and a 1½ to 2 barrel capacity per still.

There is still much to be learned about Shaw's stills. Neither the type of fuel nor the mode of heating is known. The shape of the still is not known; the bottom might have been truly hemispherical or still smoothly curved for easier cleaning but somewhat flattened for more even heat distribution. Nor is it known whether the stills were bricked in for a more even heat distribution and longer lasting bottoms.

Most perplexing are the iron and copper meshes. Neither the type of impurities nor the mode of operation or theory behind it are given. Clearly he did not have in mind physically separable impurities such as twigs, leaves and grit as the meshes are passed by a vapour and not by a liquid and only the latter would transport impurities of this tvpe. Perhaps Shaw felt that some chemical reaction or physical adherence of the foul smelling impurities would take place at the meshes but this seems unlikely as, according to one report, the "oil is not deodorized

but merely distilled." There is a plausible explanation. Shaw might have seen the wire meshes as a safety measure. The wire meshes might have been cool enough to condense some of the heavier hydrocarbons on their surfaces thereby preventing them from entering the condenser. He would want to do this because amongst the heavier hydrocarbons were the paraffins which could solidify in and block the condenser. A blocked condenser or worm was an explosive situation.

Shaw's still was patented[1] but the patent itself and the application for it are not informative as regards the theory of operation. However, Shaw's hopes and work provide insight into the need for innovation and the problems and frustrations of pioneering technologists in a new industry. In a letter of Nov. 16, 1861, from his lawyer and filed with the patent, Shaw is said to have had a "view to introduce it in his refinery about being erected."[2] Shaw believed that his invention was the means to purify as well as simply distil.

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1. Patent Office Archives, Ottawa, Canada Patent Number 1308, granted H. N. Shaw of Cooksville, in the County of Peel, for "An Improved Dome Petroleum Separator." Quebec, dated 16th December, 1861.

2. Patent Office Archives, Ottawa, unpublished letter of Feb. 10, 1862, from Thomas R. Johnson, lawyer, to Department of Agriculture.

> My invention consists in the construction of an apparatus for separating and refining petroleum, and removing all inflammable properties without the use of chemicals, by constructing a still with a dome, in the mouth of which are placed two or more perforated diaphragms, the perforations in each of which are finer than those in the one immediately below it .... By this means the Agitator now used for washing the oil is rendered unnecessary, and the use, as at present, of chemicals, in the refining process which injure the lubricating properties of the oil, is dispensed with, while the oil itself retains a much greater body and is consequently of greater value than oils distilled by the means now used.[1]

How quickly he must have been disappointed as were many others. Shaw's "Dome Petroleum Separator" was a fine still but no refinery. The patent drawing shows the side and bottom of the 'still' meeting at an angle of slightly over 90° and one can only hope that a founder or boilermaker advised him that the junction should be rounded for more even heat distribution and easier cleaning.

There is little more that can be said about the equipment for small-scale distillation until further material is found. There is, however, more to say about the small distiller. Not all of the "small" men were content to remain as distillers and some ventured

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1. Patent Office Archives, Ottawa, Canada Patent Number 1308.

into rather chequered refining careers, two aspects of which are to be examined here: financial and technical.

There was a tradition of small distilling and/or refining companies each of which although unique were united by common bonds of small size, low budget, and near bankruptcy. They often drifted into bankruptcy only to pop up again with new partners and/or name only to again feel the pressure of elements such as larger, more efficient, and less debt-ridden companies. A reduced tax assessment was one of the means that small companies sought in order to fight bankruptcy, particularly after their periodic fires, explosions and other disasters. These characteristics and the vicissitudes of small companies are best illustrated by following a few individuals.

On March 13, 1862 it was announced that two oil partnerships in Sarnia were changing their composition by mutual consent. Harrison O. Wood and Thomas Miles of Smith, Wood and Miles, oil refiners, were leaving Erastus Smith to run the refinery. E. Smith, perhaps the same Erastus Smith, was leaving another company in the hands of R. S. Chalmers and A. McLagen.[1] One week later

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1. Observer, Mar. 13, 1863.

> a serious accident occured at the Monitor Oil Works here, by which Mr. H. O. Wood, of the late firm of Smith, Wood and Miles, got the first and second fingers of his right hand so much injured as to render amputation necessary. While the steam engine, which turns the agitator was in motion, Mr. Wood, in cleaning off the dust from some part of the machinery, had his hands drawn into some part of the gearing. The obstruction caused the machine to stop, the steam pressure being low at the time, otherwise the accident must have been serious.[1]

Mr. Wood was not given much time to lament his fate as the following month he was in court fighting a law suit.[2] Mr. Wood was not alone in his troubles. The previously mentioned Chalmers and McLagen, calling themselves R. S. Chalmers and Company had managed to have two fires at their refinery one of which caused $700 damage.[3] Smith[4] hired the law firm of Mackenzie and Gurd to sell his

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1. *Observer*, Mar. 20, 1863.

2. *Observer*, April 24, 1864.

3. *Observer*, Mar. 27, 1863 and *Observer*, April 24, 1863.

4. E. Smith claimed to be living in Oil Springs. The Lambton *Gazetteer* for 1864 did not list him as a resident but this is probably because he did not buy advertising space in the *Gazetteer*. George Smith, without whose help this thesis could not have been written, warned me of the danger of relying on the *Gazetteer*. Although he described it in terms totally unsuitable for inclusion in this thesis I take the liberty of translating his words to read "notoriously unreliable". George Smith is not a descendant of E. Smith.

refinery "at a great bargain and upon easy terms."[1] It is possible that Smith was more interested in having his taxes lowered than in selling his refinery. The Sarnia Township Council reduced his assessment from $1,000 to $600.[2] Two years later Mackenzie and Gurd were still or again trying to sell his refinery[3] but there is no evidence of further tax reductions for Smith.[4]

After being out of the news for some time Chalmers and McLagen emerged with a new refinery which was the

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1. Observer, July 22, 1864. The refinery is described as follows: "Situated in the Township of Sarnia on the River St. Clair, located midway between the Grand Trunk and Grest Western Railway stations. Said refinery has two 18 barrel stills, a 20 barrel agitator, ten horsepower steam engine, with every convenience for manufacturing oil. The refinery is so located that it can easily be supplied with either Canadian or Pennsylvania crude oil ...."

2. Observer, Oct. 14, 1864. See Observer, Oct. 15, 1866 for another example of reducing the tax assessment for a refinery, this time for one that had suffered a fire.

3. Observer, Aug. 20, 1866.

4. It was not only the small refiners who asked for, received, and were aided by tax concessions. Much of the history of oil refining in the Lambton area in the nineteenth century is a story of tax reductions, exemptions and other bargains. Imperial Oil was not above such measures.

site of two explosions in less than a month.[1] These explosions undoubtedly irritated Messrs. Cameron and Bryce, the occupants of the dwellings next to which Chalmers and McLagen had erected their refinery. Cameron and Bryce, having no respect for the fine odiferous traditions being established in the Sarnia region and which survive to this day, petitioned Council and then the Courts complaining about the oil refinery only to be told that admittedly refineries were a nuisance but one of a special kind -- "a necessary nuisance, the good outweighing the bad."[2]

Not all of the problems faced by the small distillers and/or refiners were financial, many were technical.[3] The diary of John H. Fairbank for the period 1862-64[4] provides first hand information and insight into the life of an oil producer and refiner operating on a

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1. Observer, Oct. 22, 1869 and Observer, Nov. 5, 1869.

2. Observer, Mar. 5, 1869.

3. This is not to say that many were not both; an unwanted explosion and fire is a technical problem but would also generate a financial one: finding funds to rebuild.

4. This is the only period for which his diary has survived and there are no entries for many days. Mr. Ed. Phelps, Regional History Librarian, Lawson Library, University of Western Ontario, London, Ontario, and I have Xerox copies of his diary. [Hereinafter referred to as Diary].

rather small scale and frequently very close to financial disaster. The diary, at present unpublished,[1] is a record of frustration, uncertainty, worry and physical hardship. The diary speaks for itself and is worth quoting in extenso as an aid to understanding and illustrating some of the problems faced by men such as J. H. Fairbank.

> At work at refinery at treating room. Still not runn. (20 Sept., 1862)
>
> Up late. (1 Oct., 1862)
>
> At work at refinery set agitator shafts etc .... Blains horses would not work horsepower. Agitator leaked and devil to pay generally .... Eakins took out pipe from well, not pumping to-day, got bearing made by wheelright. Blains team took one load (5 bbls.) to refinery. (8 Oct., 1862)
>
> At blacksmiths helping to make inside supports for bottom bearing of agitator shaft. (9 Oct., 1862)
>
> Raining like mischief all day, made corduroy road for horsepower, got very wet and muddy. (10 Oct., 1862)
>
> Allens tanks burnt last night fought fire and watched till 5½ a.m. (30 Oct., 1862)
>
> Went over to refinery, thence down to look for barrels, running around all day accomplished but little. (6 Nov., 1862)
>
> Collecting barrels and barrling oil all day. At refinery all night. (7 Nov., 1862)

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1. It is hoped that the Diary will be published by mid 1973.

Saw Shaw peddling oil he is a big ass, would do a smashing business at selling molasses, candy and peanuts ye gods, what money he would make at training dogs. (13 Nov., 1862)

Was at Refinery seeking for a team none to be had both Kings teams at home 1 sick 1 waggon broken. (20 Nov., 1862)

Didn't treat cause lazy teamsters. (22 Nov., 1862)

Out early after team got one at last too late to work. (1 Dec., 1862)

Colder than thunder everything froze up still not run. (6 Dec., 1862)

Rather quiet Christmas minus turkey and "such like". At work in mud and oil all day, such is Enniskillen. Received nothing from somebody, gave something to nobody, total 0. (25 Dec., 1862)

damned by every luck no cash. (26 Dec., 1862)

a year of hard work and small returns. (31 Dec., 1862)

John scadeddled at rain. (10 Jan., 1863)

devil to pay generally. (21 Jan., 1863)

Poor Mr. H. N. Shaw drowned in his well to-day. In him I have lost one of my best friends in Enniskillen. A good man and most obliging neighbour. Sad, sad, sad calamity. (11 Feb., 1863)

Borrowed carboy acid. (10 Feb., 1863)

chemicals not arrived. (20 Feb., 1863)

telegram from Abner "Come home immediately your wife very ill" .... Heaven preserve my poor wife. (14 March, 1863)

At work at pump no go. The devil is in it. (26 June, 1863)

Finished coopering crude oil barrels filled some with tar. (3 July, 1863)

> Went down to corners and hunted crazy man until 1 a.m. (9 July, 1863)
>
> Put up new spring pole. (8 Aug., 1863)
>
> The Sarnia hounds made a dead set on me with a hellish plot; but failed "the dog is ahead" (21 Aug., 1863)
>
> Altered pump. (25 Aug., 1863)
>
> Refused $600 for ½ oil and lot interest perhaps very foolish. (31 Aug., 1863)
>
> Pump out of order took up both valves. (12 Jan., 1864)
>
> Looking all over for inch gas pipe. (28 Jan., 1864)
>
> Set men to dipping oil from creek. (5 Feb., 1864)
>
> Old "Weasel skin" took up his seed bag and deluged the lower world with water. (19 Oct., 1864)
>
> Run still. Fichit away nearly all day, about as miserable a day as I ever put in, run till dark and quite fully resolved that I won't run a damned leaky old kettle that acts as if it would "go up" any minute for love or money -- don't want to become as nervous as old made, and feel like a coward all the time. I'm down on the thing and wont stand it any way. Can stand work as well as any one but dam a leaky still, them's my sentiments. (18 Oct., 1862)

As was the case with many of his fellow refiners and distillers J. H. Fairbank did not stay a small operator. Some did not last, leaving no richer and perhaps poorer than when they started, but others became big operators. Fairbank did no leave the oil business but expanded and diversified his business interests. Although he did not stay in refining, he made a considerable fortune as a

producer and shipper of oil as well as in other business ventures associated with the production of oil and the growth of an oil town.[1] Although Fairbank did not invest heavily in refining there were men of the high financial status that he was to achieve who were investing in the oil regions at the time when he was a struggling entrepreneur vowing " ... I won't run a damned leaky old kettle that acts as if it would "go up" any minute for love or money ...."[2]

When James Miller Williams started refining he was neither new to the world of business nor was he a pauper. However, Williams was apparently not refining in Enniskillen and the first 'large' scale refinery, probably the first refinery, in Enniskillen was that which began operation in Petrolia in August 1861. The refinery was built by the Petrolia Refinery Company, a company which was composed principally of Bostonians and was therefore sometimes referred to as the Boston company or a Boston company. One of the leading investors

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1. A biographical study of J. H. Fairbank is to be found at the University of Western Ontario. Edward Phelps, John Henry Fairbank of Petrolia (1831-1914): a Canadian Entrepreneur (unpublished M.A. thesis, University of Western Ontario, 1965).

2. Diary, Oct. 18, 1862.

was a Mr. Adams of Boston who came to live in Enniskillen and so the refinery was sometimes referred to as Adams' refinery, a source of confusion because there was also an English firm -- A. A. Adams and Co.[1] It is perhaps only logical that a company from Boston should invest in a refinery in Petrolia as Boston and Hamilton were the two original refining centres for Enniskillen crude.[2] The cost of the refinery is variously given as $11,000[3] or $10,000.[4] Either figure represents no mean sum when compared to other refineries.

There are two extant descriptions of the Petrolia Refinery Company works and its operation; neither of these give a complete description or one in which it is apparent that the author fully understands what is going on.[5] Using the two descriptions it is possible to begin building a

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1. See Globe, Sept. 12, 1861 and Globe, Mar. 12, 1862.

2. Hunt, "Notes on Petroleum," pp. 248-249.

3. Globe, Sept. 12, 1861.

4. Globe, June 21, 1861.

5. Globe, June 25, 1861 and Globe, Sept. 12, 1861. There are several reasons why the accounts are confused and incomplete. Many of the reporters, particularly at this time, were not familiar with a refinery and did not know how it should work and what it was to do. Refinery operators were loath to give out information which might be of interest to competitors.

composite picture of part of the physical plant. Contrary to present refinery practice, all buildings were of wood. The still house was 40 by 34 feet and contained 6 stills: 3 on each side of the building. The stills, presumably of boiler plate but perhaps cast, each had a capacity of 15 barrels of oil and were built into strong high brick cylinders. Outside the still house was an elevated tank 16 feet in diameter and 7 feet deep; from this tank the stills were filled by gravity flow. Outside the still house were "6 tall, band-like tanks, 3 on each side of the building [still-house] standing in a direct line with the stills: from each still-head there runs into each of these vessels an iron pipe, connecting with a worm in the vessel."[1] The worm(s) emerge from near the bottom of these cold water filled tanks or vessels. On the end of the worm is a cock and a small iron pipe running vertically for 8 or 10 feet. The pipe is the vent through which the gas escapes as oil trickles out of the cock. From these cocks are iron pipes leading to what is described as an immense, perfectly water-tight tank which is made in two divisions and has been sunk into the yard.

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1. Globe, June 25, 1861.

To add more to the description is rather difficult because the two accounts conflict. The reason for such a state of affairs is unfortunate but not surprising. The equipment was sophisticated and new to newspaper reporters and editors, most of whom did not understand what happened in a refinery. Refinery owners and operators, often convinced that they had at last hit upon the 'secret' of successful refining, were loath to let reporters into the works. Reporters were often deliberately given false information, shown only part of the processes or in other ways had information withheld. It is not surprising that very few knew what was going on inside the refineries.

When the stills were cool some type of valves or stop cocks would be opened and the stills would be filled or 'charged' from the elevated crude tank. The stills would be fired, the temperature of the crude would rise and various fractions, beginning with what were called benzoles, would distill off and be conveyed to the worm which descended through a cold

water tank.[1] During the passage through the worm, and depending on various factors such as the rate of vapour flow, some of the vapours would liquify[2] and be conveyed to the storage tank. Other vapours would remain uncondensed and be conducted up the vent pipe and escape into the atmosphere. To this point all that has been performed is a distillation not differing in its essentials from that described as being carried out in the Shaw equipment.

Returning to the description of the physical plant, it is to be noted that the underground tank was in two parts and "as the distilled oil runs in from the stills into the first division a close watch is kept, and the

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1. The Globe, June 25, 1861 states that "from each still-head there runs into each of these vessels an iron pipe, connecting with a worm in the vessel." It is not clear whether we have each still head connected to only one pipe and to one worm or to 6 pipes and 6 worms, i.e. every worm being connected to every still-head. That the latter was the case seems doubtful, too complicated with too many places for leaks and breaks; on the other hand some form of such a system would have a certain advantage as it would allow, say, the use of 3 stills and 6 cooling tanks and worms.

2. The greater the percentage of vapours liquified the greater the percentage yield and the greater the theoretical profits. Liquifying the lighter fractions will give an illuminating oil with a lower flash point and of greater potential danger to the customer. This applies to all products but is more crucial with a lighting oil.

quality of the oil is observed. The moment any defect in the oil is noticed it is conveyed into the second division and again put through the still."[1] The defects would be those of colour and clarity; the oil should be of a clear amber colour or lighter. A lack of clarity or darkening of colour would, depending on the judgment of the operator, be cause for confinement to the second division and redistillation.[2] Here the two accounts differ somewhat and should be looked at separately. Although rather long the remainder of these two descriptions merit quotation in their entirety.

> After distillation the oil is pumped up into a leaded tank, in which works an agitator, in shape resembling a circular fan. Four steam pipes go round the tank, by means of which the oil is treated. This process, it is presumed, is intended completely to rid the oil of benzole, though upon that point, as upon many others connected with the refining, very definite information was not supplied. From the agitating vats the oil is conveyed into a tank of similar capacity and is there allowed to settle. Lastly, by means of syphons, leaving the sediment behind it, it is drawn off into the "treating" vats. These vats contain water, through which the oil passes, and in so doing clears itself of all remaining impurities. From a dirty dark green, with an odious smell, it is then converted into a light yellow liquid, with a strong, but not unpleasant odour.[3]

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1. Globe, June 25, 1861.

2. It should be noted that this description serves for the production of a lighting oil only. Much of what was pumped into the second division for redistillation would have served as a lubricating oil if such were desired.

3. Globe, Sept. 12, 1861.

> The oil in the first division undergoes a preparation through two vats placed in a small building close at hand, and is subsequently taken to the deodorizing house, in which stands 6 very handsome vats. These vats are 2 feet deep each, and about 9 feet, 6 inches in diameter, handsomely painted on the outside and on the inside as smooth as glass. The oil, after passing through these vats, is ready for the market.[1]

The two accounts simply do not coincide nor does either one make sense or sound complete in itself. The two differing accounts do not lend themselves to the creation of a composite picture of the physical layout of the refinery beyond that which has been given. One reporter knew what the refiners were doing:

> the oil refiners generally talk a great deal of nonsense about the method they have of treating the oil after it is passed through the still, for the purpose of further purifying and deodorizing it.[2]

He should have added that many refiners regarded their methods as being secret and went out of their way to prevent others from learning the full story.

To complete the description of the physical plant one need only mention the tall brick chimney[3] and the power sources. One account mentions that a "20 horse-power oscillating steam engine gives motion to the

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1. Globe, June 25, 1861.

2. Globe, Mar. 12, 1862.

3. Globe, June 25, 1861.

machinery employed."[1] The same description of the refinery makes it clear that the engine was used for pumping the oil to the agitation tank, running the agitator, and perhaps filling the elevated tank with crude. In the other account the only power source mentioned is that for pumping water.

> A large quantity of water is used in the preparation of the oil; the water is obtained from a creek and pumped up by a 15 horsepower engine, a height of some 20 feet.[2]

The production capacity was given as 3,600 gallons daily with all six stills in operation "but as it is not possible to keep the whole constantly at work, the average will necessarily be somewhat less."[3]

After the crude had been distilled the distillate needed chemical treatment. Refiners were reluctant to discuss the topic of chemical treatment and gave it an aura of secrecy blended with misinformation. The reporter who accused the refiners of talking a great deal of nonsense knew what happened in some refineries.

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1. Globe, Sept. 12, 1861.

2. Globe, June 25, 1861. For the problem of obtaining water see Globe, Sept. 2, 1861.

3. Globe, Sept. 12, 1861. Using a barrel of 40 gallons production would be 90 barrels per day which would mean that each still were charged daily. This seems rather fast work. The Toronto Board of Trade rated this refinery as producing 300 barrels per week from 5 stills. See "Petroleum", Board of Trade, 1862, p. 35.

> The oil, after having been passed through the still, is conveyed from the cistern into which it falls, to a square tank. Inside this tank is an agitator, a sort of huge chocolate mill, which, being twisted around rapidly be means of steam power, vindicates its name. While in this tank, from 3 to 4% of sulphuric acid (common Vitriol) and ½% of muriatic acid are added, and the whole well mixed up together by the agitator. To rid it of the acid, the oil is afterwards "washed" or passed through a lye made of one pound of caustic of soda to 5 gallons of water. Some makers use little more than 1% or sulphuric acid.1

There are numerous references to sulphuric acid and caustic soda but this is one of the few references that I have seen to muriatic acid.

Dr. T. Sterry Hunt is far less articulate in this respect.

> The process of refining consists in rectifying by repeated distillations, by which the oil is separated into a heavier part employed for lubricating machinery, and a lighter oil, which after being purified and deodorized by a peculiar treatment with sulphuric acid, is fit for burning in lamps.2

Fortunately, as the 1860s progressed more information about refining and refinery construction became available. The oil industry was still exciting but less glamorous and more mature. Newspaper reporters and editors were beginning to understand what they were writing about and refiners, realizing that most of them were using almost identical equipment and processes, became less concerned with secrecy.

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1. Globe, Mar. 12, 1862.

2. Hunt, "Notes on Petroleum," p. 249.

Some descriptions continued to hint at rather than describe layout and operation. Mr. Duffield's new London works was described as having

> two stills, of thirty two barrels each and containing forty gallons each to the barrel, being constructed by Mr. Thomas Brown, of the City Boiler Works ... over twelve hundred gallons of refined oil will be turned out per day .... There is a steam engine on the premises, of five horse-power, made by Mr. T. Northey, of Hamilton .... There are six bleachers or tubs for cooling the unctious liquid, and the specimens we saw on the spot, combining burning and lubricating oil, seemed clear and transparent, and we have no doubt will obtain a ready sale.1

The mention of the bleachers is important as it is the first reference to them but so much is not answered even in this regard, particularly how long the oil is left in them and how they were constructed. It was in these that final settling and clarification was to take place.

Descriptions such as the above simply do not allow one to judge the technical sophistication of the refiners and none of the descriptions are fully adequate in this respect. However, in early 1863 the first good description of a Canadian refinery appeared. The refinery was in Toronto. As with other refineries to be dealt with beyond this point, edited but somewhat lengthy quotations will be followed by commentary. The first to be dealt

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1. Canadian News, Sept. 18, 1862, p. 183.

with is that of Messrs. Duncan and Clark of Colborne Street in Toronto, one-time barrel makers in Enniskillen presently working "the largest oil refinery in the province" with an expected production of 12,000 gallons (300 barrels of 40 gallons) per week.

> The manufactory is situated on the banks of the "classic" Don and extends over a considerable space of ground. The barrels containing the crude oil, on being brought from the depot, are placed in the yard at the foot at two large cylindrical iron tanks, capable of holding 4,000 gallons. These tanks are supported upon timber uprights, about twenty feet high. The barrels are expeditiously and easily lifted up by means of a frame and pulleys, and their contents poured into the tanks. The object gained in raising the tanks at so great an elevation is that the oil by its own gravity flows into the stills, which are near by. Two substantial brick buildings, each 40 feet by 16 feet, contain the stills, placed in a row upon one side; and upon the other, but divided from them bv a wall, are the tubs containing the worms for condensation. Altogether there are eight stills -- one of 50 bbls., four of 35 bbls. and three of 15 bbls. each. The oil from the tanks before mentioned runs down into the stills, where it is subjected to the ordinary process. Messrs. Duncan and Clark, however, mix with it a chemical, which prevents it throwing off an offensive odour, so that their refinery is free from any other noisome smell than that which is given off from the crude oil lying in various tanks. When the heat if first applied, a very light oil, highly charged with benzine, is first developed, which, being useless for illuminating purposes, is conveyed by pipes to a cistern outside the distillery, sunk deep into the ground. Over the cistern is placed a small tub, into which the oil is raised, as occasion requires, by means of a hand pump. From the tub it is conducted to the furnace underneath the stills. Each furnace is supplied with an iron pan eighteen inches or two feet square and about five inches deep, into which the oil runs, and, being lighted, supplies sufficient heat for the distilling process. The heavy oil, likewise useless for illuminating purposes, is utilised in the same way. The tar, which is left at the bottom of the stills, is also burned as fuel, so that no part of the

crude oil, except that which passes away in gas, is wasted. As the building containing the still is most exposed to catch fire, every precaution has been taken against the calamity of a conflagration. The gas is carried into the air by pipes, and the whole of the wood-work about, the roofs included, has been coated with Montgomery's anti-flammable preparation, a manufactory of which has recently been erected in Toronto. Crossing over the yard, which is covered with barrels -- some empty, others full of oil, we pass into the main building, about 150 feet long by 35 wide and two stories high. Eight pipes, one coming from each still, are conveyed under the ground, and discharge their contents into four tanks; one of which is capable of holding 100 barrels, another 50 barrels, and the other two 16 barrels each. From these tanks the oil is pumped out into a large cylindrical treating tank. At the bottom of this tank is placed a huge "chocolate mill," which, being forced round quickly by steam-power, agitates the oil and mixes the chemicals necessary to its thorough purification. While in this tank it undergoes thirteen or fourteen distinct washings. Two treating tanks are employed by Messrs. Duncan and Clark, the largest of which has a capacity of 25 barrels. The smaller one will hold only 12 barrels, but it is to be replaced by one of a capacity of 30 barrels. In this part of the building is an immense tank, holding 40 tons of water. It is kept constantly full by the engine below, and supplies the water for the condensing apparatus attached to the stills. Much of the water used in washing the oil has to be heated; this is done by steam. It is also the intention of the owners to heat the whole building by means of steam pipes, as the intense cold causes the oil to congeal and somewhat impedes operations. From the heating tank the oil is conveyed to the bleaching vats, six of which, each capable of holding 300 barrels, stand in a row. Here it is allowed to settle; impurities which have not been washed out by the agitator find their way to the bottom, and the oil is run off into barrels of 40 gallons each for the market. The building and everything about has been covered with the anti-inflammable compound before mentioned. The process of manufacture used by Messrs. Duncan and Clarke is one of the simplest .... Though not in full working order, they are turning out a

> great deal of oil every week, for which they find an ample market. The large number of barrels piled up in the yard and two large tanks in course of construction capable of holding about 24,000 gallons of oil attest the extent of the business they expect to carry on; and we see no reason to fear that they will be disappointed. The cost of the refinery will be about $12,000.[1]

One of the features which should be noted is the considerable hand labour involved. Unloading and raising barrels for emptying was a hand operation and the use of hand pumping is also mentioned with no mention of steam power pumping for other than water.

There was much emphasis on safety by separating buildings, presumably to minimize loss in event of fire, fire-proofing, and some ground storage - although it was only the very dangerous light oil used as fuel that was stored in the ground. The use of underground lines was probably a measure of convenience as well as safety. The fact that they were using light oil, heavy oil, and tar as fuel is significant but not surprising, an economy measure to be expected in an urban centre such as Toronto with its high wood prices. Not surprisingly, the plant was directed towards the production of one rather than a number of saleable products. The entire description is permeated by a general vagueness and imprecision which

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1. Canadian News, Jan. 29, 1863, p. 75.

reaches its height in the almost complete lack of information regarding the chemicals and chemical processes used. The shortcomings of the description are not entirely unexpected. The refiners still had a few secrets to keep. The processes of chemical treatment were complicated and the general newspaper reader was probably not interested in them.

One refinery in Oil Springs was regarded by the Oil Springs Chronicle as "one of the best in the country." It contained "a splendid oscillating engine" and "a fine large agitator, with a patent bellows attachment."[1] No purpose was given for the bellows; it was probably used to pump air into the agitator to increase its effectiveness.

It is not until 1866 and 1867 that one finds something resembling a first rate description of a refinery, both are from the pen of Alexander Somerville. In 1866 Somerville described himself as "One who is interested in the Place", and in his first article discussed the Canada Rock Oil Company of the Montreal firm David Torrance and Co.

> The estate on which the refinery stands measures fifty acres .... This is the only elevated dry land which I have seen on either side of Main-street, and that thoroughfare is three miles long .... The entire management -- financial, architectural,

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1. Canadian News, Jan. 19, 1865, p. 39. Based on Oil Springs Chronicle.

mechanical, and chemical -- has been committed to an eminently competent gentleman, Mr. James Lockhart. So also the sinking of five wells on another estate of the company .... These works, in most of their parts original and as a while unique and without a rival in perfect adaptability to the purposes aimed at, were evolved from his own ingenious mind .... The excellence of the tie roads on this estate, as compared with other traffic courses about Oil Springs village, first attracts a stranger's notice. In these sound smooth roads is seen the first sign of a systematic business.

The most conspicuous object here is the treating-house, a building one hundred and ten feet long, forty feet high. The next is a square brick chimney, forty-five feet high, distant from the treating-house about sixty yards east. Four or five yards on the west side of the brick chimney is a row of ten stills, each resembling the body of a railway engine, elevated from the ground about eight feet, raised above a furnace and enclosed in walls of fire-brick, only the rounded back and sides of the still being visible. One has a capacity for eighteen barrels, three for thirty barrels each, one for thirty-five, one for forty-five, and four for sixty-five barrels each.

They are six tanks underground, having capacity for six hundred barrels. A hatchway above each may be lifted to look down. For me one brief glance into the only one of them was enough ....

In commencing to construct the refinery, the first thing requisite was to obtain a copious supply of water by sinking a well. It was found here in abundance. Nowhere else about Oil Springs is there such another fountain of pellucid water. During the winter just past, half the houses and most of the hotels of the town were supplied from this well. A York shilling a barrel was charged ... to defray expense of fuel for the engine and for wages of the attendants. The refinery not having been then in operation, the well would have been closed .... The absence of clear water everywhere else about Oil Springs gives the Canada Rock Company a pre-eminent advantage in producing the purest translucent oil for illuminating purposes.

There are three steam engines supplied by steam from one boiler, which is situated beside the tall brick chimney. One at the well, distant from the boiler about twenty yards; the steam rushes to its service through an iron pipe. The second pumps oil at the stills. The third is in the treating-house; it raises distilled oil to the tanks on the second floor, to be washed by the water which descends from the floor above. It also drives the rotary egitators, which plunge in the tanks mingling oil and water together in the process of washing; afterwards oil and sulphuric acid in the process of deodorising. A glance at the intervening space of sixty yards between the stills and the treating-house suggests the idea of the house being anchored to the earth by a series of iron rods an inch and a half in diameter. They look like guys thrown out to keep it steady. These are iron tubes. One conducts steam in very cold weather to the water tank at the top of the house, and to the oil tanks on the second floor, to raise the temperature and keep the liquids in working condition. Another conducts heavy oil back to the stills for redistillation. The steam to the engine within the house goes through an underground pipe. We shall arrive at the uses of the others presently.

Let us begin with the crude oil ... brought from wells ... by barrels, waggons, horses; it is emptied into an underground tank. The engine power which draws water from the well is applied and pumps this oil from the underground reservoir to a tank raised eight or ten feet above the ground and situated out on an open space by itself clear of all other buildings. From this elevated tank, its size eight or nine feet on the side, five feet deep, a series of pipes convey the crude liquid and distribute it to whichever of the six underground tanks it may be required to convey it. From these it is raised by engine power and distributed by pipes into the different stills. The stills, when sufficiently filled, are hermetically closed and the furnace fires lighted underneath. Delicate thermometrical instruments indicate degrees of heat. At about five hundred degrees vapour begins to boil off. The petroleum is boiled to six hundred degrees. At that heat all goes off in vapour but the coal tar; having no other vent, the vapour passes through the iron pipes which conduct it to the condensers.

These are circular tanks eighteen feet diameter, open at the top, within which the pipes from the stills are coiled round and round and interlaced so as to expose the largest possible surface to the action of cold water. This flows copiously in from the pump well and escapes to a drain less or more heated. By the lower temperature of the cold water the vapour within the coil is condensed to oil. The various pipes deliver their contents into one tank. From this receptacle the finer and lighter portion of the fluid is drawn off into another tank, and by a force pump sent through one of the pipes across the sixty yards of interval already notified, poured into a general receiver on the ground floor of the treating-house, then raised by steam pump to the second floor and distributed in several tanks. The heavier portion of the fluid is "run to ground," that is, it is run into an underground tank, to be pumped up into the still and boiled until it becomes vapour, to be again condensed and in turn "treated" in the house like that which went before it. This heavy oil, without being redistilled, would be a good lubricator for machinery if there was a market of demand; but here the company prefer to distil and redistil so long as oil can be extracted. The first gross residuum is coal tar. That finds its way into an underground tank of its own and is raised by steam pumps to a still of its own. There a heat of eight hundred degrees is applied. All the oil is not then extracted in form of vapour, but the still is red hot and any higher degree of heat would fuse the entire apparatus to a burning liquid. After the coal tar there is an ultimate residuum of coke. This is highly inflammable. It would be valuable as fuel in the fusing of iron ore or other minerals when an intense heat is required, but cannot be used as fuel here ....

Let us follow the oil which is now in the treating-house; it is in circular tanks on the second floor. In each there is an agitator, a vertical shaft moved by machinery from below, with horizontal arms. Water, which has been raised by force-pumps to a tank on the highest floor, now descends through a hose to be mingled with the oil. By the touch of a lever the machinery

moves, the agitator plunges. A wild white foam rises. The two elements, oil and water, seem at wrathful discord. They refuse to mingle. The agitator lashes them to fury. When they have held ten minutes of this conflict, the disturber stops. There is a minute of subsidence and repose. The two unamalgable elements separate in peace -- water to the bottom, oil to the top, calm, quiescent, with laughing dimples on its face as if conscious of being uppermost after the battle. The water and impurities adhering to it are drawn off. The tank is not long at peace. Down comes a second rush of water to vex and wash that petroleum which had slept in the crevices of deep rocks through ages the remoteness of which human sagacity can make no feasible conjecture .... A conflict goes on as before. The disturber stops .... Water is drawn off .... A third time comes a rush of water from above. The tank is again full, and the steam-engine on the ground floor, god-like in power, slave-like in obedience, gives motion to the agitator. Again it raises a splutter, a commotion, a foam, and stops. This third water subsides and is drawn off.

A fourth rush of water from above. "What again? .... Who else washes in this way?" "Perhaps no one. But here is an unlimited supply of clear water. Here are perfect mechanical appliances for washing the oil which no other refiners possess.... Make the future illuminator ... pure as the appliances of science and the supervision of chemical genius can render it. And so once more the agitator plunges, the foam rises .... Again there is repose; water departs into the depths of some deep, dark conduit; rock oil remains.

The washing is at an end. But though the thing that has been cleansed so pesistently is now translucent and pure to the scrutinising eye, it has an odour, not so disagreeable as before the ordeal of the fiery furnace, yet so pungent and suggestive of discomfort that if not removed this lustrous illuminator would not be admitted within the festive hall or the peaceful domestic dwelling. The operator looks round. On a bench stand several rows of concial-looking, round bellied, short-necked bottles, each caged within a basket, and wide enough to hold several gallons

> of liquid. These are carboys and contain sulphuric acid. He takes one, and according to the quantity of oil to be treated so he pours in the acid. The engine once more gives motion to the agitator and foam arises as before ... they boil into a frothy rage. Sulphuric acid hisses, fumes, and smokes, rising into the air in the form of vapours, carrying certain component parts of the petrolific fluid with it. The revolutionary agitator stops. The work is done. The pungent acid has departed in a cloud and carried the unpleasant odour of the oil with it. Inoffensive to the organ of smell, translucent to the eye, the rock oil refined is now drawn from the several circular tanks where it was treated, for more than one or two were simultaneously were in operation, and is conducted to a general receiver, a circular vat on the ground floor about twenty feet in diameter and six or seven feet deep .... The operator knows that he is only a practical chemist and mechanician. The stranger, under the influences of the charm before him, questions if the chemical genius at his side is not a magician.
>
> A tap in this receiver of refined rock oil runs it into barrels. These barrels of fluid go forth upon the commerce of the world, their first destination being Montreal.
>
> From the time that the crude petroleum was emptied from the waggons into the first underground tank until now that it is filled into the barrels of commerce, faultless in puritv, human hand has never been in contact with it, nor has human strength been applied to any one of its many transitions. All has been effected by machinery. Five men only are required to work the entire apparatus, complicated though it be. That portion of the refinery at present working gives out two hundred barrels in six days. But in the course of a few months, if demand should justify the appliance of all stills and conjoint machinery, the establishment could turn out from four hundred and fifty to five hundred barrels every six days.1

Here is evidence for a very well designed and sophisticated refinery. It is no jerry-built operation.

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1. Canadian News, June 14, 1866, pp. 374-375.

The stills are of known configuration a type of still common in the early twentieth century, and fire-bricked for more even heat distribution and fewer burnt-out bottoms. A burnt-out bottom could produce a serious conflagration and the Canada Rock Oil establishment was designed, as much as possible, to avoid that calamity. Most noteworthy of the fire prevention measures was the placing and systems used for powering steam engines. The engine itself was best placed close to very volatile and inflammable products but this is not true of the boiler and therefore one boiler was used to supply steam to three engines from a safe distance. In the interests of safety, some of the steam pipes were underground -- an arrangement offering much in convenience as the site would be less cluttered with obstructing steam lines. Unlike the refinery of Messrs. Duncan and Clark, there is virtually no hand labour nor is there the above ground storage.

Both Duncan and Clark and Canada Rock Oil seem to have in common the pursuit of a single saleable product but note the differences in how they go about it. Duncan, distilled only once and used the non-illuminating cuts as a fuel. Canada Rock Oil with their own woodlot

used wood for fuel but re-distilled the non-illuminating cuts in order to increase their yield. Canada Rock Oil was 'cracking'.

In his next article Somerville identified himself as "The Whistler at the Plough", a reference to an earlier work of his.

> In the first week of November, 1866, I was at London, C. W. That place is favourably situated for the business of oil refineries .... Seven refineries are situated in proximity outside the city limits on the east. My footsteps were directed to the one most recently established, which was said to be distinguished by appliances, mechanical and chemical, not in use elsewhere. This was the Atlantic Petroleum Refinery of H. Waterman and Brother ....
>
> WATERMAN'S REFINERY
>
> Arrived within the gateway. I looked upon a square enclosure of two acres. On the east side, opposite the entrance, rose from amid low brick buildings, holding in their interior furnaces and stills, a tall chimney. In the centre of the premises was a flagstaff ... and ... a fountain throwing aloft streams of pellucid water, which is there found abundantly under the sandy soil and pumped by steam power. On the left hand and the right, as the visitor advances inward are terraces of four or five feet high .... These terraces are the fire-proof roofs of the petroleum vaults; tanks of crude oil under one, stores of refined oil under another ....
>
> On the right hand at entering is a two-storied house, and beyond, at a safe distance, having regard to fire, steam boilers and furnace. In the house is a 12 horse-power engine and a pump -- the latter a wonder in its way, as will presently appear. On the upper floor is a tank in which oil after distillation is washed with cold water and chemically treated. This is called the treating-house. The stills (five in number) are on the further side of the square, eastward. Near them but sufficiently distant for safety, are

the cooper's shops, where barrels are prepared, painted outside, washed with liquid glue within.

Waggons bring loads from the railways (ten barrels to a load), and men roll the barrels upon the platform which adjoins the first terrace of flower beds. A load of empties are taken away to be forwarded to Bothwell, or Petrolia, or Oil Springs, or Sarnia, and refilled. Underneath the platform a pipe leads to a tank which holds four hundred barrels, and from that tank pipes lead to three others, holding in all sixteen hundred barrels. When this crude oil is to be elevated into the stills, which stand in a row about eighty feet distant eastward, a stopcock in the underground tube is opened and the liquid flows westward into a subterranean receiver below the treating-house. The engine being in motion, the pump raises the petroleum and sends it through a tube to the opposite side of the yard, where it disperses by other tubes into the five stills, each holding forty-five barrels. The stills are made of boiler plate and are built with brick, each over its furnace, each with its brick flue. Cordwood fuel is applied -- thirty cords of hardwood per week. When the still is heated vapour rises, but not escaping upward it issues through the gooseneck of the still, technically the retort, and, conducted by two pipes from each gooseneck, it goes under the influence of cold water and is condensed. These pipes containing the vapour are disposed in coils around the interior of a tank holding one thousand barrels of water. These different pipes unite in one when the vapour is condensed to fluid, that one conducting the distilled fluid to a receiver underground beneath the central flower beds. It holds two hundred barrels.

The product from crude petroleum which went into the stills is of five kinds. The first "run" is a light fluid, termed benzole, mostly used by painters. This flows about three hours. It is succeeded by the heavier fluid, which becomes burning oil. This runs thirty or thirty-two hours. The last "run" is heavy oil, used for lubricating purposes. When the last vapour has been condensed, a tap is opened in the still and tar runs out. A bituminous remainder crystallises when cooling, and is called coke. It is highly inflammable, and with a mixture of other fuel is welcomed in foundaries

where intense heat is requisite. To get this coke from the interior, the still must be opened at the top and men enter in bodily with shovels. To cool the still and give the men breath, the pump forces from the west side currents of fresh air. By merely turning one of a series of stop cocks within the engine-house that pump at Isaac Waterman's will send crude oil into the stills, or water into the condenser and into steam boilers and into the chemically treating tank on the upper floor, or fresh air into the stills, or raises the distilled oil from the central subterranean receiver to the tank on the upper floor, where it is to be washed by the plunging agitator and chemically treated. The stills being cleaned to the bottom, are again hermetically closed and refilled. This is done twice a week, but could be accomplished three times a week ....

The treating tank on the floor overhead is built of boiler plate and weighs four tons. Its capacity is one hundred and forty. The distilled petroleum, having arrived there, is washed with water, the agitator, driven by steam power, plunging round and round, lashing the oil and water to fury -- water foaming, oil foaming, mingling in the tumultuous revolutions .... When the agitator stops, petroleum comes up with a smile on its face ... and water, subsiding to the bottom, slinks away into a drain, indicating by its colour and odour that in the battle upstairs it has given petroleum a dressing.

Sulphuric acid is poured into the tank, but petroleum does not await the revolutions of the agitator to show excitement; it fizzes, hisses, and evinces a natural antagonism against such treatment. The machinery moves fast, faster; then slow, slower, stops. The acid has absorbed the gaseous foul breath of petroleum; but itself is foul, it cannot remain. To expel it, water is admitted. Again violent revolutions, conflict, tumult .... After the storm a calm. Oil comes up .... Water runs to its drain. Again a chemical agent is applied, Isaac Waterman's own peculiar secret. It is this which gives the oil from Waterman's Petroleum Works pre-eminence. He declined to say what it is. He has elaborated it by experiment through several years. The pelucid fluid, void of odour, bears witness that

> he has a secret not available in other refineries. A new kind of stop-cock at the stills and about the pumps, his own invention, and various portions of machinery and appliances prove him to be a mechanical genius as well as a chemist.
>
> The purity of the oil is ascertained by the hydrometer and the fire test .... If it stands these tests, the fluid is passed to a tank from whence it is barreled in the storehouse underneath the flowery terraces. There two thousand barrels may be stored, but when I was at the works in November the demand for the article kept the cellars comparatively empty.
>
> Isaac Waterman is, in years and in features, youthful. He has studied and made experiments inspired by a love of chemistry .... The older brother, head of the firm, is a dry goods merchant; they are reputed wealthy. The power of capital to command the services of skilled labour was seen in the erection of these works. From the day when the first spadeful of earth was turned to the day when stills, engine, pump, and all accessories were in full operation, only seven weeks elapsed. The pump was made at Brooklyn, in the States; all the other work -- stills, tanks, and construction, emanated from little London city, except the engine -- that was made by Beckett and Sons, of Hamilton.[1]

Before making any comments about the refinery it should be noted that London had seven refineries just outside the eastern limits of the city -- the prevailing winds were from the west.

Both Waterman's and the Canada Rock Oil Company refineries were models of safety, well-planned efficiency and care. The concern for safety is seen in his extensive use of underground storage facilities as well as the relative isolation of boilers and furnace. The many

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1. Canadian News, Feb. 28, 1867, pp. 131-132.

uses to which steam engine and pump are put is an example of an imaginative quest for cost-cutting efficiency. The use of the air pump would not only make the life of the workmen less unbearable but in facilitating cooling of the stills would decrease down time or the time between charges. Another example of Waterman's desire to maximize the benefits from his machinery is seen in his condensing equipment. The simple expedient of two 'worms' or condensing pipes from each gooseneck would, at a given rate of flow, result in an increased liquid yield, or, while retaining the liquid yield of one worm, allow a faster rate of distillation while retaining the same rate of cooling water flow. Either way the water pumped by the steam engine is doing more useful work than were he to have only a single condenser. Uniting the various condenser pipes meant fewer pipes to be potential sources of leakage.

Waterman was not 'cracking' or re-distilling but was pursuing more than one product of commercial value. The account of Waterman's refinery is the first to introduce reliable 'run' times and a job that must have been extremely unenviable -- removing coke from the stills. In previous descriptions there is no

mention of this essential task. From the manner in which Somerville treats the air pump and Waterman's use of it, Waterman's method of cooling and ventilating his stills was unique in that area -- a boon to workers' health as well as faster cooling and therefore greater use of the stills.

In 1869 the Ontario Carbon Oil Company of Hamilton erected a still in Petrolia of hitherto unprecedented size: 2,000 barrels. Due to its size it was dubbed and always referred to simply as the Mammoth Oil Still. Plagued by fires and explosions it was neither a financial nor a technological success. It did have one interesting feature -- "a most perfect syphon" for discharging the "liquid tar or residuum."[1] Beyond the syphon the Mammoth Still seemed to embody no innovations other than sheer size. One of the reasons why the Mammoth Still was initially praised was because of its heat distribution.

> The fires are so well calculated that the bottom of the still is equally heated; but when they get their apparatus for burning tar in the furnaces completed, they expect to be able to distribute the heat over all the parts with less trouble.[2]

Heat distribution was one of the problems demanding some attention during the 1860s although from what is to be

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1. Canadian News, Aug. 26, 1869, p. 137.

2. Canadian News, Aug. 26, 1869, p. 137.

given below it seems to be part of the refining game, a game in which the goal is not to prevent the appearance of burnt-out bottoms but just to make their occurrence less frequent. The Wyoming News-Letter was confident that burnt-out bottoms would not be a frequent acquaintance of Mr. Ward.

> He has adopted a new plan of building his stills, which diffuses the heat evenly to all parts, and therby prevents the bottoms from burning out as quick as they otherwise would.[1]

The praise that has been given to some refiners should not lead one to believe that there was little room for improvement. Innovations such as continuous charging[2] were still far in the future but it should be clear that during the 1860s the distillation and refining facilities in Canada West had undergone considerable improvement. But refining requires more than the construction of the physical plant and it is these other aspects of refining that are to be dealt with below.

Lambton crude had a very objectionable odour which

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1. Canadian News, Sept. 23, 1869, p. 198. Based on Wyoming News-Letter.

2. During the 1860s there were schemes and plans for continuous charging but there is no evidence that they were adopted in Canada until the 1880s or later.

was not removed by distillation. It was therefore necessary to subject the oil to further chemical treatment. In none of the refinery descriptions quoted above is there a complete description of the chemical processes. The one description which might appear to be complete, Somerville's of the Canada Rock Oil Company, seems incomplete as there is no neutralization of the sulphuric acid.[1] In describing Waterman's refinery, Somerville again shows no recognition of the need for the neutralization of the acid although he recorded what was undoubtedly the addition of a base to the acid.

> Again a chemical agent is applied. Isaac Waterman's own peculiar secret. It is this which gives the oil from Waterman's Petroleum Works pre-eminence. He declined to say what it is. He has elaborated it by experiment through several years.2

An unknown reporter warned his readers about secretive refiners.

> The oil refiners generally talk a great deal of nonsense about the method they have of treating the oil after it is passed through the still, for the purpose of further purifying and deodorizing it.

Not only did the reporter forewarn his readers he also informed them as to what really took place -- agitation with "3 to 4 per cent of sulphuric acid (common Vitriol) and ½per cent of muriatic acid." To get rid of the acid

1. Canadian News, June 14, 1866, pp. 374-375.

2. Canadian News, Feb. 28, 1867, p. 132.

the "oil is afterwards "washed" or passed through a lye made of one pound of caustic of soda to 5 gallons of water."[1] The above starts to explain Fairbank's purchases of chloride of lime, acid, and soda.[2]

In most Ontario refineries the process was probably essentially the same. The distilled oil would be washed and agitated to help remove water soluble impurities, allow heavier than oil impurities to separate out, and give remaining volatile vapours a chance to evaporate off. The next step would be the addition and agitation with sulphuric acid which "partly removes sulphur and nitrogen compounds, precipitates asphaltic and other resinous materials and removes olefinic and unstable compounds."[3] The remaining acid would be neutralized in an acid-base reaction to form insoluble sulphate salts which along with other precipitates and unreacted base would be removed from the oil in subsequent washings and agitation. Most of the hydrogen sulphide would have escaped during agitation. All of this might then be followed by further settling and bleaching.

It remains to ask whether or not the oil was treated

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1. Globe, Mar. 12, 1862.
2. For one example see Diary, Feb. 18, 1863.
3. Purdy, Petroleum, p. 205.

in the manner described and whether or not the treatment would deodorize the oil. It is very likely that the oil was treated in the manner described but, for reasons previously discussed, one cannot be entirely certain. Another reason for the lack of certainty is that there were other methods available and being used during the 1860s.

Refining with sulphuric acid was not without its complications as the strength and/or quantity of acid used was very important. Too much acid would give oils partially charred and discoloured while too little would not remove the impurities leaving an oil likely to change colour after packaging.[1] It is probably because of the difficulties presented by sulphuric acid that some refiners used no acids, only alkalies.[2] J. H. Fairbank bought chloride of lime and there was a method of refining using chloride of lime.

> In treating for disinfecting and removing the impurities from petroleum and products thereof, it has been usual to employ chloride of lime in a dry state and in combination with other matters, but which, however, is very imperfect in its action and far from obtaining the desired result.
>
> According to an invention ... by Mr. B. Azular, of Rotherhithe, the oils are treated with a saturated solution of chloride of lime, and, as

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1. Tate, Petroleum, p. 70 and "On Refining Petroleum," Manufactures for Upper Canada, II (Dec., 1862), 374-375. From Philadelphia Coal Oil Circular.

2. Tate, Petroleum, p. 75.

> it were, washed in the solution. For this purpose the oil is placed in a suitable vat or vessel and the solution poured over it, the solution sinks through the oil, and is drawn up from the bottom, and by a pump or other means is elevated again to the top, and so a circulation of the solution in the oil is kept up and the impurities thus abstracted from the oil, which is rendered clean and quite free from offensive smell ... If the oil is not very bad the same solution may be used again. If the oil is bad the solution will be found to have acquired the taint of the oil and must not be used again.
>
> If the oil is very bad it may be found necessary to repeat the process with a fresh solution, in that case a second vat is provided, the top of which would reach the oil tap of the first vat; the treated oil is then drawn from the first into the second vat and washed in water. After the oil has been separated from the water, the latter is drawn off and a second solution is then thrown on the oil, and the process proceeds as before. Instead of the solution of chloride of lime being applied at the top and drawn up from the bottom of the vessel, the oil may be forced in at the bottom of a vessel, containing the solution of chloride of lime, when it will rise through the solution and may be drawn off at the top, repeating the operation as often as may be necessary according to the quality of the oil operated upon.[1]

Other proposals were somewhat further removed from those already introduced. One system of deodorizing was to use "deutoxide or nitrous gas" from nitric or fuming nitrous acid or from the gas itself.[2] The basis of another proposal was chromic acid which gave chromic

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1. "Purification of Petroleum," Manufactures for Upper Canada, V (July, 1865), 193. From Mechanics' Magazine.

2. "Deodorizing Petroleum and Mineral Oils," Manufactures for Upper Canada, III (July, 1863), 218-219.

oxide as one of the intermediate products. Metallic oxides were later to play an important role in effective refining and the proposal using chromic acid, although its fate is unknown, merits attention.

> A patent has lately been taken out in England by James Stuart, of London, for the treatment of petroleum and crude oils of all descriptions obtained from coal, shale, bitumen or wells .... A solution of chromic acid in water is a novelty ....
>
> For every 100 gallons of crude oil to be treated, 12½ lbs. of bichromate of potash is taken and dissolved in 12½ gallons of water, and to this solution is added 1½ gallons of vitriol (the sulphuric acid of commerce). The solution of chromic acid which is thus obtained is added to and mixed with the oil, the oil is being kept intimately mixed by churning or agitating it for about an hour. By this treatment a quantity of pitchy matter and other impurities are separated from the oil, and the oil is deprived of the greater part of its unpleasant smell. The chromic acid is at once converted into oxyd of chromium, with which the excess of sulphuric acid unites, and forms sulphate of chromium. The mixture is now left at rest until separation takes place ... usually ... one to two hours. The oil then being the upper portion is drawn off into another vessel, agitated with a solution of soda for about an hour. This is done to wash out or neutralize any acids remaining in the oil. The solution of soda, which it is preferred to use, is made by dissolving 12½ lbs. of soda ash of commerce in 12½ gallons of water, and adding that quantity to every 100 gallons of oil to be washed. After one hour's agitation, the whole is left at rest until the oil has separated from the soda solution, after which the oil is placed in an iron still, and distilled. The distillation is continued until the whole bulk of oil distilled reaches .840 sp. gr. at 60° of temperature. The distillate is then to be placed in a proper vessel, and treated as before by churning or agitating with a solution of

chromic acid in water .... bichromate of potash ... water ... oil of vitriol ... agitation ... left at rest until the oil is separated from the solution of sulphate of chromiun and impurities. Afterward, the oil is drawn off into another vessel, and washed by mixing or agitating it, for half an hour or thereabouts, with one-fourth its bulk of water or one-fourth its bulk of lime-water. When the water or lime-water has completely separated, and the oil has become bright, it will be fit for use as an illuminating oil. The heavy oil remaining in the still is distilled to dryness, and may then be treated by any of the known methods for obtaining paraffine or lubricating oil. The chromic acid used in the process above described may be obtained otherwise than from the bichromate of potash; it is, however, usually most convenient to employ this salt. It is preferred to apply the chromic acid in the first place to the crude oils, because the solution of chromic acid, by removing the pitch, tar and other impurities from the oil, enables it to be distilled at a heat much lower than would otherwise be necessary, and so prevents decomposition taking place in the still. It is found that, after treating some crude oils with a solution of chromic acid, and distilling ... the oil so obtained is of too dark a color to be used as an illuminating oil. In this case, the oil is treated by churning or agitating it with two per cent (by bulk) of oil of vitriol for about an hour, then allowing the whole to rest until the acid, tar or sludge is separated from the oil. The oil is then drawn off into another vessel, and agitated with two per cent of powdered quicklime or dried chalk for another hour, or until the smell of sulphurous acid has left the oil. There is then added 25 per cent (by bulk) of water, and the whole is agitated for a quarter of an hour; after which time the mixture is left at rest until the oil has become bright, when it is drawn off for use; but if the oil is not of a good color, it is re-distilled. If there is difficulty in getting the oil perfectly bright, there is added to every 100 gallons of oil, 26 lbs. of common salt dissolved in 8 gallons of water, and the whole is agitated well together for a quarter of an hour; then, when

> left at rest, the oil will become perfectly bright. In no case however, is the oil of vitriol used for treating the oil, if it can be avoided, as it unites with and decomposes a great part of the lighter oils, and this it is wished to avoid as much as possible. The chromium used in the process may be recovered either as sulphate or oxyd, as desired.[1]

Most significant in the above is the extreme care recommended, including double treatment, and the use of a metallic oxide. The Journal of the Board of Arts and Manufactures for Upper Canada reported in 1866 that olive oil could be purified from its acid by treatment with lead.[2] Two years later it reported the use of lead, actually an oxide, in deodorizing petroleum.

> ... the disagreeable odor of petroleum oil can be taken away by treating the oil with a solution of oxyd of lead in caustic soda, and will certainly remove all such odor as sulphur compounds might communicate to the oil.[3]

A further source of information for refining processes but one that is less helpful than might be expected is the patents issued in Canada during the 1860s. It is necessary to be extremely cautious when using the patents of the 1860s as historical evidence for industrial

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1. "On the Purification of Bitumens and Coal Oil," Manufactures for Upper Canada, I (June, 1861), 154-155.

2. "Misuse of Oils," Manufactures for Upper Canada, VI (Sept., 1866), 250.

3. "Deodorizing Petroleum Oil," Manufactures for Ontario, VIII (Jan., 1868), 20. From Mechanics' Magazine.

practice because there is generally no indication whether or not the idea was workable. Patents did not have to be workable and it is clear that some are the work of weekend chemists working with small flasks, perhaps not even that but only a drawing board. The difficulties in using the Canadian patents of the 1860s as a guide to industrial practice is best illustrated by looking at continuous charging of petroleum stills.

Continuous charging was not successful during the 1860s but there are patents for various means of continuous charging methods of distillation and/or refining. The first of a number of patents using continuous charging was issued to a Petrolia engineer, John Fleming, on Dec. 4, 1861. He claimed that he could accomplish continuous charging by preheating but the most interesting statement is that "By the present mode of distilling these oils, about 35 per cent of surface and 60 to 70 per cent of rock is all that is obtained for luminating(sic) purposes"[1], a statement in agreement with other evidence regarding yields. Patents granted to men who were not oil refiners or engineers show considerable faith in a combination of continuous charging and the formation of a partial vacuum. The patents

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1. Patent Archives Library, Ottawa, Canada Patent Number 1304.

granted to Otto Rotton of Kingston,[1] a Doctor of Medicine, and that of Samuel Stevens,[2] a gentleman of Belleville, are on these principles. There is no evidence that they were used nor that even a pilot plant or small scale models were ever constructed. The same may be said of Dr. Rotton's patented system in which petroleum was supposedly distilled and in part deodorized by being sprayed from a pump onto hot cones heated by superheated steam and then condensed.[3] There is nothing in the patent description or application to make one suspect that it ever left the drawing board.

Patents relating to the chemistry of refining reflect practice already mentioned and there is no evidence to indicate that the ideas patented were put into practice. A patent granted in 1862 to a Toronto gentleman[4] is representative of the exaggerated and I believe untested claims that are found all too frequently. Chloride of lime, sal soda, manganese and lye, violently shaken with crude will NOT "render the oil nonexplosive"

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1. Patent Archives Library, Ottawa, Canada Patent Numbers 2108, 2109, 2196.

2. Patent Archives Library, Ottawa, Canada Patent Number 2369.

3. Patent Archives Library, Ottawa, Canada Patent Number 2217.

4. Patent Archives Library, Ottawa, Canada Patent Number 1343.

as claimed. It would produce a very dangerous lighting fluid. John Tindall was a Sarnia "chemist -- late of Liverpool"[1] and his patent is probably a reflection of the careful English practice discussed elsewhere and not Sarnia practice.

Tindall's patent and three others do supply evidence that some people were thinking about refining in terms of sulphuric acid and soda as well as their own special ingredients. Two patents were granted to a London refiner, John Robinson, in 1867.[2] In both spirits of turpentine and rosin are used, supposedly to help improve the quality. In both he mentions treating with sulphuric acid in the ordinary way. That sulphuric acid was probably used heavily in refining operations is indicated by the fact that Robert Loftus, an Enniskillen oil refiner, patented "A new and useful process by which the Sulphuric acid used in refining distilled petroleum ... can be recovered and made equal to the acid in its original state for ... Refining ...."[3]

Although there was considerable variety in refining methods available and perhaps in use it is not a totally

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1. Patent Archives Library, Ottawa, Canada Patent Number 1513.

2. Patent Archives Library, Ottawa, Canada Patent Numbers 2303, 2360.

3. Patent Archives Library, Ottawa, Canada Patent Number 1664.

bewildering situation. Most of the refining was probably conducted using the sulphuric acid and soda process perhaps with some modification. There were some individuals who had rather startling claims and methods but it is safe to mention these and then ignore them. Representative of this type of 'refiners' is Dr. H. E. Tweddles of Pittsburgh, Pennsylvania. Dr. Tweddles was the inventor of a process for manufacturing oil by which the

> hazard and risk attendant upon the use of fire in distilling the crude petroleum, and the expense and nuisance of subsequent purification by acids and alkalies, are entirely avoided. Steam is the only agent used, and it is utterly impossible to ignite the oils during the operation. But six or eight minutes is required to convert crude into refined oil.1

An important question to ask about any refining process was whether or not it worked and that of Tweddles would not, particularly if used with Lambton crude.

The major stumbling block to the acceptance of Lambton crude as a source of an illuminant was its odour. It is necessary to distinguish between two types of odours associated with petroleum. The first is common to all crudes, particularly in warm weather, and is merely due to the evaporation of the more volatile

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1. "A New Process for Manufacturing Oil," Manufactures for Ontario, VII (Dec., 1867), 324.

components. Odours of this type are common to crude but less so to refined products, particularly the less volatile. One can be rid of these odours by taking cuts which are less volatile. The second type of odour is the more serious and that which caused the smell of petroleum to be likened unto garlic, onions, leeks, and antiquated eggs. These odours are due to the presence of various sulphur compounds. The antiquated egg smell is due to hydrogen sulphide and the onions, leeks, and garlic, i.e. the "skunk" due to the presence of mercaptans -- organic sulphur compounds with a particularly offensive odour.[1] There were also other odour-causing impurities. Various organic acids, particularly naphthenic acids have an offensive odour.[2] Using the acid and soda refining procedures some of the offenders would be removed. "Hydrogen sulphide ... is readily removed from petroleum products by washing them with an alkaline (lye) solution"[3] and "organic acids are readily removed from petroleum products by treatment with a lye solution."[4] This leaves only

1. Purdy, <u>Petroleum</u>, p. 68.

2. Purdy, <u>Petroleum</u>, p. 70.

3. Purdy, <u>Petroleum</u>, p. 68.

4. Purdy, <u>Petroleum</u>, p. 70.

the stable mercaptans, compounds with a skunk odour and which according to generally accepted opinion were not eliminated until the Frasch copper oxide process removed the sulphur of the mercaptans as copper sulphide. The Frasch process was not introduced until the 1880s,[1] and with it complete sulphur removal was at last possible. But in the period before the 1880s, particularly the 1860s, there were numerous claims that deodorization has been solved. The existence of these claims must be explained, particularly those in the late 1860s as it was in the late 1860s and the early 1870s that Canadian crude and refined finally commanded a large export market.

Purity is a relative term. Pure was basically that which was acceptable in the market place whereas the impure was not. Purity was a very subjective concept and varied in time and place. It is also necessary to realize that that which is possible is not always that

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1. Herman Frasch, "A Record of Achievement in Chemistry, 1912," in Readings in Technology and American Life, ed. by Caroll W. Pursell, Jr. (New York: Oxford University Press, 1969), pp. 127-130.
   Ross, Petroleum, pp. 45-46.
   Aaron J. Ihde, The Development of Modern Chemistry (New York: Harper & Row, 1970), p. 675.
   All three accounts differ in one respect. Ross says that Frasch was "employed as a chemist in one of the Canadian refineries" whereas Frasch claims that he "bought a refinery in Canada" and there made the discovery. Ihde has Frasch working "in the petroleum industry in Cleveland, where he invented a process for desulfurizing crude oil ...."

which is done. Coal gas producers were faced with the sulphur problem just as were the petroleum refiners and there is considerable literature on the hazards of sulphur in coal gas as well as how to deal with it. An excellent source of information on the sulphur in coal gas controversy is the Journal of the Royal Society of Arts. When reading the Journal it becomes apparent that what coal gas producers were seeking was not absolute elimination of sulphur and its compounds but their reduction to acceptable levels using not laboratory but large scale processes which were economical.[1] Keeping in mind the flexible nature of purity and its value as an advertising claim, one should not condemn as charlatans those who claimed to have deodorized the oil. One should look at refining techniques before passing judgment.

The refining techniques explain why Canadian crude refined in England or the United States was being sold easily. The answer is simple -- care and time. Canadian refiners simply did not give their oil the time and care that it needed. In each step taken by Canadian

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1. This is based on reading many of the articles in the Journal during the 1850s and 1860s. Should the reader wish to pursue this subject it is easily done because the Journal is very well-indexed.

refiners less time was spent than was the case with their American and British counterparts.[1] Not only did Canadian refiners take less time at each stage of the refining process but they only did once what their British and American counterparts did twice, sometimes three times. It was not until 1868 that Canadian oil refined in Canada began to gain acceptance as a qualtiy product -- a product which could compete in foreign markets. The key to this success was careful work rather than technological innovation.

> The chief difficulty in the way of a foreign market has always been the quality of our refined oil ... our refiners are now in a position to challenge comparison with the best American "standard white" .... The method is by double distillation and double treatment. The process is simple -- the oil is distilled in the usual way ... the distilled is then treated with acid, and the whole is pumped back into the still and re-distilled ... and then treated again. This double distilling and double treating ... produces with ordinary attention, an oil white, free from objectionable odours, of a gravity of 44 deg., and which will stand a fire test of 120 deg., or five deg. over the standard. Some thousands of barrels

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1. See for example any of Tate, Petroleum, p. 70, Canadian Native Oil, pp. 26-27, or "On Refining Petroleum," Manufactures For Upper Canada, II (Dec., 1862), 374-375. From Philadelphia Coal Oil Circular.

> have lately been made by different manufacturers with a uniform result.1

It is significant but not surprising that careful and therefore more effective refining, by the standards of the day, made its appearance in Canada so late. The Canadian oil industry was much smaller than that in the United States and it was only in the late 1860s that the refining industry started to take on the air of a permanent business rather than a gambling and get-rich-quick scheme. It was only at this time that a few dared to seriously try to move from supplier of raw or semi-processed materials to supplier of finished product. By this time a nascent Canadian chemical industry had been sufficiently established to provide a ready and reliable source of essential refining chemicals.

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1. Canadian News, Nov. 12, 1868, pp. 309-310. Based on the London Free Press. The phrase "different manufacturers" is not to be interpreted as meaning many as there were only two or three, see Canadian News, Dec. 3, 1868, p. 356, and Canadian News, May 13, 1869, p. 294. However, the Observer, April 16, 1869, has following to say: "Concerning the deodorization of oil; this has been done by Messrs. Duffield and Brothers, Waterman and Brother, Spencer and Keenleyside and some others in London, and by the Canada Land and Mineral Co., of Petrolia, under the management of Mr. James McMillan." Unfortunately nothing is said about the methods involved and so one just does not know how effective the "deodorization" might have been.

Canadian crude oil did suffer from a disability not present in the oil from the American oil fields worked in the 1860s. Many in Canada were unwilling to face up to this problem and were content to supply crude, distilled, or a refined unworthy of the name rather than a refined which was worthy of the name. There was no question that double refining "cost extra labour and expense" and some wondered whether or not it would pay.[1] The critical year for testing double treatment was 1869. Hopes were high by the start of the year.[2] By August there was no question.

> Since the new mode of treating the oil has been discovered and proved to be the thing wanted, an export trade of important dimensions has sprung up.[3]

The nature of "the new mode of treating the oil" was not revealed; it might have been regarded as common knowledge. Undoubtedly the oil was carefully given double treatment and was probably also given the previously mentioned lead oxide treatment.[4] Canadians were able to break into foreign markets by coming up to world

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1. Canadian News, Dec. 3, 1868, p. 356.

2. Canadian News, May 13, 1868, p. 294.

3. Canadian News, Aug. 19, 1868, p. 116.

4. "Deodorizing Petroleum Oil," Manufactures for Ontario, VIII (Jan., 1868), 20.

standards, i.e. British and American standards. Canadians were definitely giving their crude the care and time needed for double treatment. In Canada there was also the knowledge that lead oxide could be used in refining petroleum. An important patent was issued to John Fry, a Quebec merchant. Fry did not claim to originate the process nor to have used it, he merely learned it while travelling in France. The patent, granted Dec. 24, 1868, was for "A new and useful art of purifying and deodorizing Petroleums and other liquid and solid Hydro-carbons ...."

> The Hydro-carbons and especially the Canadian Petroleums are much benefitted by treating them both before and after distillation with a solution of oxyde of lead in caustic soda or potash. This solution which is called caustic lead is made by adding Lytharge or other oxyde of lead in fine powder to a strong solution of the caustic soda or Potash in water, and then boiling them together, till the solution is saturated, the excess of lytharge falling to the bottom of the vessel, from which the clear caustic lead is poured off for use. The Petroleum or other liquid Hydro-carbon, should be well agitated with about five per cent of the caustic lead, before it is distilled, and with about three per cent after distillation, when it should be finished in the usual manner with sulphuric acid and alkali or other mode of treatment.[1]

Removing the mercaptans was a difficult task because during the 1860s and 1870s the state of the art in organic chemistry was such that the offending mercaptans

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1. Patent Office Archives, Ottawa, Canada Patent Number 2933.

had not been identified and isolated. The identification work began in the 1880s.

Before 1870 Canadian refiners were capable of producing from high sulphur Lambton crude a refined illuminating oil which, by the standards of the day, was odourless. But it was costlier to produce than a poorer quality product and unfortunately was often not produced. Throughout the 1870s and 1880s newspaper editors reminded the oil interests that "one thing the people have a right to demand is a good article of oil, which our crude is capable of turning out if properly handled."[1] Many Canadians were not getting a good illuminant, but it was not because one could not be produced in Canada. There were Canadian refiners turning out a first rate product as well as an inferior one. The refiners instituted a double price and double quality system whereby the best oil was reserved for export and sold for less than the inferior product sold in Canada. The details of this system and why it was able to survive are outside the

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1. Canadian News, June 3, 1874, p. 424.

bounds of this thesis.[1] The fact that such a policy existed led to so many complaints that it is easy to erroneously underestimate the level of technical sophistication which the Canadian oil industry possessed by the end of the 1860s.

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1. The reader wishing to pursue this further should begin his research in the Monetary Times which published more or less regular reports on the oil industry. The reports are virtually devoid of any technical information but are very good on finance.

CHAPTER IV

PRODUCTS AND USES OF PETROLEUM.

The Petroleum Boom in the late 1850s and early 1860s was quite unlike any previous mineral boom in Canada. It was different in that one had to search not only for the mineral but also for uses for it, a situation quite unlike that in the iron and gold booms going on at the same time. In this respect the closest thing to the oil boom was the excitement created by Mr. Hodges and his peat machines.[1] It had been known for many years that peat existed in Canada but James Hodges was the first to convince Canadians that it was a valuable resource. Hodges desigend and constructed machinery to produce a solid fuel from peat. Contemporary and earlier schemes in Europe aimed not at a single product but the production of gas, oils and other products, all in the same manufactory. In Canada, more was expected of petroleum than of peat. Petroleum was the promising youth of Canadian industry during the 1860s. Caught up in a dizzying whirl of optimism, boosterism, and

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1. This is the same Mr. James Hodges of Victoria Bridge fame. During 1863 and 1864 peat frequently was given better coverage in the Canadian News than was petroleum The interest in peat throughout the 1860s is shown by the coverage given it in various engineering and scientific journals.

promotional drumbeating, petroleum, a resource not yet sufficiently analysed or understood, was pronounced fit to produce far more than the technological environment of the 1860s would allow. Many promises were unfulfilled but in order to understand the petroleum industry in Canada during the 1860s one must examine expectations as well as accomplishments.

There was no shortage of sources repetitiously extolling the virtues and promise of petroleum. Newspapers, government, scholarly and scientific communications and publications as well as oil company prospectuses and releases all joined in listing and discussing the many products that were to be produced from petroleum.

Lambton crude petroleum was analyzed scientifically to determine its potential. The first attempt at analysis was probably that made by Dr. Antisell. On February 19, 1853 "Thomas Antisell, M.D., Consulting and Analytic Chemist" wrote and forwarded a "report on and Chemical examination of a sample of Asphalte forwarded

to me by Mr. Tripp."[1] This important document is to be found in Appendix B and will be only summarised and commented upon here. It was not the free liquid petroleum that was being analyzed but the petroleum and earth mixture found in the Gum Beds of Enniskillen township and subsequently roasted by Tripp and Williams. Much of what Antisell said applies to free liquid petroleum because most of the report dealt with the uses of products liberated from their earthy prison. Although he mentioned various uses Antisell felt that "the manufacture of

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1. Doctor Antisell was noted as the author of: Thomas Antisell, The Manufacture of Photogenic or Hydrocarbon Oils from Coal and other Bituminous Substances Capable of Supplying Burning Fluids (New York: D. Appleton & Co., 1859).

   The book is well worth reading but should be read in conjunction with the scathing review of it. See Frank H. Storer, "Review of Dr. Antisell's Work on Photogenic Oils, & C.," American Journal of Science and Arts, XXX (Nov., 1860), 112-121, 254-264.

   As news of the resource of Enniskillen spread, one of the frequently made comments was "unfortunately ... it is not coal." See Free Press, May 27, 1858. The petroleum was soon regarded as a resource "second in importance only to coal". See Leader, June 30, 1860.

volatile liquids and an illuminating gas appears to be its more appropriate uses."[1] As a source of liquids the "asphalte" would provide an excellent solvent, particularly for Gutta-Percha. The liquids might, when mixed with alcohol, provide an illuminating fluid.[2] The other way to turn petroleum into an illuminant was conversion of the "asphalte" into gas, as was done with coal. It was also expected that it would be useful in the production of Japan and other varnishes as well as mastics and cements including a hydraulic cement. No potential use was given for the paraffin. Of the various uses for the asphalt or oil earth given by Antisell, Charles Nelson Tripp probably put most faith in its potential as a source of an illuminating gas. Several years after Antisell's report Tripp sent a 1,450 pound sample to the Hamilton Gas Company and received a favourable report. The full text of this report is to be found in Appendix C. Virtually nothing is known about

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1. This judgment was generally held of liquid petroleum. It is worthy of note that Antisell did not mention lubricants.

2. As it turned out, petroleum products helped to banish this type of dangerous mixture; the alcohol and turpentine mixture was not to be replaced by petroleum and alcohol. Petroleum was to do away with the use of alcohol, mixed or unmixed, as an illuminant.

what Tripp really felt could be accomplished with the crude petroleum of Lambton. In 1855 the International Mining and Manufacturing Company was awarded an Honourable Mention for its asphalt in Paris[1] but it is not known to what extent Tripp was responsible for this achievement or even if he was still with the company.

The Journal of the Board of Arts and Manufactures for Upper Canada, throughout its relatively short career, was a most enthusiastic booster for Canadian petroleum. The Journal gave the impression that petroleum was a product with many uses and was constantly drawing attention to and encouraging various uses for petroleum. In one letter petroleum was identified as a source of "burning oil", "Paraffine", for which there were a variety of unnamed uses, a lubricant; and, from the refuse, a coke that "burns freely in a grate."[2] Considerable faith was put in petroleum's future as a source of gas. Petroleum could be utilized as the sole source of gas, as in the Thompson and Hind process[3], or for the enrichment or "naphthalization"

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1. J. C. Taché, Canada at the Universal Exhibition of 1855 (Toronto: John Lovell, 1856), p. 372.

2. Fisher, "Letter," p. 46.

3. "Petroleum Gas," Manufactures for Upper Canada, II (Sept., 1862), 272.

of coal gas.[1] The advantage of the naphthalized coal gas over conventional coal gas was that the former gave less heat for the same amount of light,[2] a state of affairs not to be taken lightly particularly in crowded quarters. In Canada the petroleum gas was also cheaper than coal gas.[3]

The chemical industry was seen as a potential beneficiary (customer) of the petroleum industry which would produce "benzole", "nitro-benzole" (oil of bitter almonds), "aniline" and dyes produced from aniline.[4] The benzole was sometimes referred to as naphtha but whatever the name it was seen as a product of potentially wide use, primarily as a solvent for gutta percha, caoutchouc, resins, and gums. Due to its powers as a solvent, benzole could be used in "extracting oil from

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1. "New Application of Rock Oil," Manufactures for Upper Canada, I (Nov., 1861), 286-287. [Hereinafter referred to as "New Applications of Rock Oil"].

2. "Illuminating Gas," Manufactures for Upper Canada, II (April, 1862), 103-104. From American Gas-Light Journal. "Artificial Illumination," Manufactures for Upper Canada, III (April, 1863), 120-122.

3. "Petroleum Gas," Manufactures for Upper Canada, II (Sept., 1862), 272.

4. "The Petroleum, or Rock OIl of Canada," Manufactures for Upper Canada, I (Mar., 1861), 61. [Hereinafter referred to as "The Petroleum, or Rock Oil of Canada"].

wool before dyeing", removing grease from clothing as well as removing "tar paint, oils, grease and resin."[1] Petroleum also had recognized antiseptic and preservative qualities.[2] Petroleum could also be used as a paint oil.[3] With the shortage of turpentine brought about by the War in the United States eupion oil or benzine was pressed into service and performed admirably as a substitute for turpentine in paints.

One of the less glamorous uses to which a petroleum product -- heavy oil -- was put was for cleaning boilers.[4] One would not expect petroleum's use as a boiler cleaner

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1. "The Petroleum, or Rock Oil of Canada," pp. 29-31. "The Flowing Wells of Enniskillen, and the Importance of Finding a Market for Canadian Petroleum in Europe," Manufactures for Upper Canada, II (Mar., 1862), 66. [Hereinafter referred to as "The Flowing Wells"]. Alex. S. Macrae, "The Oil Springs of America and Canada," Manufactures for Upper Canada, II (Mar., 1862), 89-90. [Hereinafter referred to as "The Oil Springs"].

2. "The Flowing Wells," p. 66.

3. "Alex S. Macrae's Circular for September," Manufactures for Upper Canada, II (Oct., 1862), 320.

4. "Oil of Asphaltum for the Preservation of Boilers," Manufactures for Upper Canada, III (Mar., 1863), 96.

to rival that as an illuminant but it is representative of a whole host of minor uses. It was felt that petroleum would be important as a source of residue to serve as a substitute for India Rubber in producing picture frames and medallions.[1] Other minor uses were as a source of a new anaesthetic "rhigolene",[2] leather blacking,[3] and a waterproofing for leather.[4] Perhaps the most unusual application, particularly so in the mind of many today, was its use in oiling the sea to calm the waves in storms.[5] The Oil Districts of Canada credited petroleum with being "a useful stimulant to torpid bowels, promoting in such a temperament the alvine discharge."[6] A. Norman Tate gave a very comprehensive treatment of petroleum in

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1. "Petroleum Residuum a Substitute for India Rubber," Manufactures for Upper Canada, V (Oct., 1865), 280.

2. "A New Anaesthetic - Another Use for Petroleum," Manufactures for Upper Canada, VI (July, 1866), 196.

3. "Petroleum Blacking," Manufactures for Upper Canada, V (Aug., 1865), 217.

4. "Paraffine Water-proof," Manufactures for Upper Canada, VII (June, 1867), 165.

5. "Oiling the Sea," Manufactures for Upper Canada, VII (May, 1867), 138.

6. John F. Tyrrell, The Oil Districts of Canada (New York: The American News Company, 1865), p. 32.

his Petroleum and its Products (1863). Amongst the various uses mentioned by Tate were the production of "pavement", "roof covering"[1], and a gas which could be compressed and put into cylinders[2].

One of the most compelling reasons for promoting the varied uses of petroleum was to stimulate capital investment in the industry. In 1861 the agents of the Canadian Native Oil Company conducted a thorough investigation into all aspects of the oil industry in Canada. Their activities raised considerable interest in the press and were followed by the publication of a pamphlet, including a stock prospectus, on the oil industry in Canada[3]. The pamphlet, The Canadian Native Oil, did not present any new uses for petroleum but it is a good example of the optimistic and enthusiastic literature associated with the oil industry in the 1860s. One naturally expects to find a certain 'official optimism' in any company or stock promoting publication but the optimism in The Canadian Native Oil is one that

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1. Tate, Petroleum, p. 46.

2. Tate, Petroleum, p. 61.

3. Canadian Native Oil Company, The Canadian Native Oil: Its Story, Its Uses, and Its Profits: With Some Account of a Visit to the Oil Wells (London: Ashby & Co., 1862). [Hereinafter referred to as Canadian Native Oil]. It is a work of 52 pages followed by a four page prospectus for the company.

was shared by a large portion of the Canadian public.

> The discovery of the apparently inexhaustible supply of mineral oils in Canada and the States of North America can scarcely be over-rated in a commercial point of view.[1]

Although a wide spectrum of commercial products was anticipated the petroleum industry in Canada settled for a single line of product development. One of the consequences of pursuing only one type of finished product was that much of the petroleum was wasted unnecessarily. Petroleum, a mixture of hydrocarbons, is never found pure. "Materials other than hydrocarbons are considered impurities by petroleum refiners even though they are as much a part of crude oil as the hydrocarbons."[2] In 1860 an anonymous writer left a definition of pure oil. "When I say pure oil, I mean that it was entirely free from water ... having only ten to fifteen percent, at most, ... of impure substances mixed with it."[3] It then appears to be neither surprising nor wasteful to learn that Williams' loss in preparation was about 20%.[4] The figure

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1. Canadian Native Oil, p. 12.

2. Purdy, Petroleum, p. 66.

3. Smith, S25-20, July 19, 1860. The initials of the author are J. A. Jr.

4. Free Press, Aug. 5, 1859. It is very doubtful that the loss is as low as 20%, twice that is probably more realistic especially if he was seeking only an illuminant. Robb, "Petroleum Springs," p. 316 gives a figure of 30 to 35%.

quoted is only for the initial distillation and one might therefore expect the final figure to be higher. The Shaw distillation apparatus was held in high repute and it gave fifty per cent illuminating oil; "the remaining fifty per cent is all lost."[1] There were probably very few whose useable distillate was as low as 50% of crude but none who got 100% as some seemed to think possible. The Petrolia Refining Company was credited with producing from first distillation "ten and one half per cent of benzole and forty two and one half per cent of oil fit for illuminating purposes."[2] It was added that "the balance consists of oil which may be used for lubricating machinery, and of refuse, from which ... Mr. Hugh Shaw has discovered a method of extracting paints and dyes."[3] There is no evidence to suggest that the balance was utilized. Standard practice seems to be reflected in the statement that

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1. Globe, Mar. 12, 1862. It is only fair to note that his equipment could be modified so as to yield other products.

2. Globe, Sept. 12, 1861. In another, earlier, description a gas vent pipe is described; benzole would be lost through the pipe unless it were modified, see Globe, June 25, 1861.

3. Globe, Sept. 12, 1962.

> no use is made of the benzole which is allowed to escape, and the refuse oil finds its way into the creek. A black substance, very much like coal, accumulates in the stills and is burned in one or more of the stoves of the establishment.[1]

The "benzole" and the "refuse oil" could also have been saved and used or sold but careful attention to reducing waste was not a major concern of refiners in the early 1860s.

When the Canadian Native Oil Company agents were conducting their research they seemed rather pleased with the work of two refiners, Messrs. Adams (the English Co.) at Petrolia and Mr. Bush of Enniskillen.[2] The yield of Adams was 25% of white refined oil, 20% of lubricating oil and 15% of mineral turpentine for a total of 60% of crude converted into usable products. It was optimistically reported that the company was conducting experiments in England to increase these figures and that the 15% of mineral turpentine, when sold, "pays the cost of all the crude oil, and the expense of manufacture employed for other products."[3] From 25 barrels Bush was able to produce

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1. Globe, Mar. 12, 1862. The refinery is referred to as that of Messrs. Adams and it is therefore not clear if this refers to the English or the Boston firm.

2. Montreal Herald, Oct. 22, 1862. I did not systematically search the Montreal Herald but found a reference to the article in some papers in the Smith collection.

3. The statement is perhaps true under optimum conditions but these were rarely found in Canada.

2½ barrels of benzole (10%), 12½ barrels of refined white oil (50%), and 3 barrels of yellow oil (12%) for a total of 18 barrels (72%) of marketable product. Bush pleased the Canadian Native Oil Company agents because he utilized his waste but he probably did little more than use approximately two gallons (8%) as fuel and discarded the remaining 20%.[1]

Thinking up uses for 'waste products' was a mid-nineteenth century preoccupation but utilizing these ideas was an avenue not quite as passionately pursued. The constant references to waste products going into the air and water tend to support this argument as do the recurring complaints that Canadian refiners were interested only in an illuminant. It is probably safe to say that the yield of commercially usable product from crude in Canada during the early 1860s, and probably throughout the decade,

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1. Montreal Herald, Oct. 22, 1862. It was claimed in the Herald that "Mr. Bush made 7 barrels of waste, which, however, is used as fuel to carry on the refinery, but the tarry portion of the refuse (about two-thirds) may be utilized as a black paint when mixed with No. 1 for coloring iron goods, engine works, outdoor fences and buildings; the other third, which is like a solid asphalt, or bright black powdered gum, will, it is said, make a beautiful varnish when mixed with turpentine.

was 50 to 60%.[1] It could have been more but few seemed to be interested in the necessary mental and physical activity necessary to bring about a higher yield.

In spite of the fact that numerous other products and uses were expected it was as a source of an illuminant that petroleum was to rise or fall.

Before the intense commercial development of Canada West crude petroleum began it was said that the Indians had been acquainted with it for a long time and "even the white inhabitants have used it in its crude state for burning in lamps, for strains in the legs of horses and for lubricating coarse machinery."[2] Tripp was

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1. The Canadian News, Feb. 7, 1867, p. 85 claimed that "Bothwell oil yields 75, Petrolia 66 2/3 ... per cent. of refined oil." These might be a bit high, especially that for Bothwell. The eptiome of optimism and gullibility comes in the 1880s with Thurston G. Hall and his promise that "three barrels will be made out of one of crude." See Observer, June 5, 1885. Hall established his business in the old Dominion Oil Company refinery. In doing this he was, unknown to the people of Sarnia, carrying on the fraudulent tradition started by the Dominion Oil Company. Hall generated a great deal of excitement in Sarnia, including the day on which it was announced that "The Electric Process for Refining Petroleum Collapses." See Observer, Oct. 21, 1887.

2. Free Press, Jan. 27, 1859.

authoritatively advised of the lighting potential of his Enniskillen "asphalte" but it is not known if or to what extent he pursued it. Williams was definitely aiming at producing an illuminant. When, in 1858, a newspaperman got a sample of the mineral oil of Enniskillen he commented that it

> has a strong pungent smell, but a piece of rag or paper, dipped into it and afterwards ignited, burns with a strong light emitting, as a matter of course, on account of the impurities in the article, a dense black smoke."[1]

Despite such an unpromising trial the reporter defended the new illuminant. "If clarified, however, we see no reason why it should not make a splendid lamp oil."[2] There might have been an element of boosterism in the report but such is far from a complete explanation. His proposal was in harmony with the existing technological milieu and accomplishments. The distillation of organic or bituminous mineral substances to produce hydrocarbon oils and gases for illumination was not new to the 1850s nor was it new to the British North American colonies. There was also a need for a safe illuminant which did not have an overly unpleasant odour.

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1. <u>Free Press</u>, Aug. 26, 1858.

2. <u>Free Press</u>, Aug. 26, 1858.

Tallow was very malodorous but it was cheap. Fluids of animal and vegetable origin had been getting increasingly expensive thereby preparing the way for new illuminants. Coal oil[1] was one of the new products, but was less readily available and more expensive than camphene. Camphene, rectified turpentine and alcohol, was extremely volatile and left a frightful toll of dead and injured in the wake of its numerous explosions and fires. Many newspapers and journals launched attacks against the sorry state of affairs, correctly identifying the culprits as human carelessness, gullibility and unscrupulousness, the basic unsuitability of camphene as a domestic illuminant and the poor design and construction of lamps. A lamp burning a volatile and potentially explosive fluid cannot be rendered completely free of danger but the danger may be minimized by making a well constructed lamp which burns a safe fuel.[2]

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1. A product made from the destructive distillation of coal, coal shale, Boghead mineral or any number of similar materials. The name coal oil was frequently to refer to petroleum illuminating oils.

2. Loris S. Russell, A Heritage of Light: Lamps and Lighting in the Early Canadian Home (Toronto: University of Toronto Press) is an excellent introduction to the development of lamps and illuminants. To see to what a great extent safe lighting fluids and lamps was a topic of concern one would be well advised to begin in journals such as Scientific American, Journal of the Franklin Institute, Journal of the Royal Society of Arts or any other similar journals.

Producing a 'safe' illuminant from petroleum presented no real technological problems once one had the crude and the refinery. It was merely a case of good distillation techniques combined with a sense of moral propriety overriding one's desire to maximize profits no matter what the consequences. The higher the flash point or fire test of the lighting fluid the safer it was, but this was achieved by distilling off the more volatile fractions thereby decreasing the yield of salable product and profits.[1] With few exceptions, unsuccessful self-policing and 'buyer beware' were the rule during the 1860s.

But a safe product is not necessarily a socially acceptable one and, to put it crudely, petroleum products stank. Much of the pungent odour common to various types of petroleum is lost as the volatile fractions are distilled off. Lambton crude had a special liability. There were some who felt that the smell was not a real liability because petroleum oils sold at a lower price than other illuminants and one soon became accustomed to the odour.

> At first the smell was overpowering, now it is unnoticed; whereas, from want of use the smell

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1. It should be kept in mind that the lighter fractions were generally discarded.

> of tallow burning, as a candle extinguished, is to those once habituated to the smell of oil infinitely more disgusting than oil ever was.[1]

The same author advocated petroleum stoves. "Petroleum, when burning, is not more offensive than soft coal." Although some people felt that it was rather unnecessary, ways were sought to make petroleum products less malodorous. Deodorizing petroleum presented both technological and ethical problems. Canadian oil producers felt that if fortunes were to be made they were to be made in foreign markets because the Canadian market was just too small for the large Canadian production.[2] Throughout the 1860s and much of the 1870s Canadian petroleum exporters fought for foreign markets and Canadian consumers suffered as a result of the methods used. Oil to be sold in Canada was of low quality and lower price. It might be argued that it was only by these measures that Canada was able to compete with the more suitable American oils marketed by large well-organized firms. Whatever the reason for its existence, this seemingly unfair marketing system did help Canadian

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1. Canadian News, April 20, 1865, p. 250.

2. The Leader, Oct. 1, 1861 commented that there was "little demand." Similar statements were to be reported for many years.

oil overcome its bad name in international markets.[1]

One of the recognized pre-commercial uses of Lambton petroleum was as a lubricant. Lubricants and illuminants were obtained from petroleum but production of the latter was on a much larger scale. By the 1850s the industrial world, a world which included Canada, was badly in need of improved lubricants. It is inconceivable that James Miller Williams, a former constructor of railroad cars, was not aware of the need. Williams' advertisements were not just for illuminating oil but also for "machinery oil."[2] Predating the earliest known advertisement for Williams' oils is a statement in the London Free Press claiming that "The International

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1. The whole problem of the bad name of Canadian oil, both refined and crude, is very complex. Initially it seems very clear but occasional pieces of evidence are to be found which raise rather serious questions. Why was it that the Oil Springs Chronicle of Jan. 22, 1863 quoted McCrae's Oil Circular, Liverpool, Jan. 7, 1863, which stated "Crude, Canadian ₤23 10S; American ₤21, same as for weeks past."? The quotation is from Victor Lauriston, "Uncertainty of Lambton Oil Evident in 1863", a newspaper article from an unidentified source and found in the Smith collection, Smith, S29-4. A study of the marketing or petroleum is very badly needed.

2. Spectator, July 4, 1860. See also July 21, 1860 of the same paper.

Mining Company" had had its oil analyzed "and it was found to possess illuminating and lubricating qualities of the highest order."[1]

Williams engaged in a form of advertising other than that in newspapers, namely showing his products at exhibitions and fairs. With only a trace of hyperbole one may go so far as to say that the 1860 Provincial Exhibition in Hamilton was notable for two reasons. It was opened by H.R.H. the Prince of Wales and it displayed Williams' oils manufactured from the Enniskillen petroleum. His machinery oil was "noticed particularly for its excellent quality as a lubrication oil, which will not clog or thicken."[2] Williams had a "still house for the preparation of engine oil" but it was destroyed by fire in 1860.[3] Petroleum lubricating oils were not just exhibition pieces. The Journal of the Board of Arts and Manufactures for Upper Canada reported that "American and Canadian railways" were using the "dark," i.e. heavy,

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1. Free Press, Jan. 27, 1859. It is possible that the newspaper is referring to the reports to be found in Appendices B and C but no mention is made in either of the use of petroleum as a lubricant. By 1859 Williams, who was not one of the original partners, controlled the company and might even have been sole owner.

2. Observer, Sept. 7, 1860.

3. Observer, June 22, 1860. For engine, i.e. lubricating, oil further refining after distillation was usually not considered necessary.

petroleum lubricating oils.[1]

It might appear that the production of lubricants was an important part of the Canadian petroleum industry but in fact most distillers and refiners discarded as waste the ingredients necessary to produce lubricants. One major refinery redistilled ('cracked') the "heavy oil" which " would be a good lubricator for machinery if there was a market of demand."[2] When Abram Farewell of Oshawa commercailly produced a machine oil from petroleum that would "neither corrode nor gum the surfaces upon which they may be used" it was an event sufficiently unusual to merit praise and attention.[3] In 1869 the Canadian oil industry in general was taken to task for, amongst other things, the "utter waste" of burning the residuum as fuel when "valuable lubricating oil and paraffine" could be produced from it.[4] Even more revealing is evidence such as that found in a list of refineries in Petrolia in 1871.

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1. "The Oil Springs," p. 89.
2. Canadian News, June 14, 1866, pp. 374-375.
3. Canadian News, Oct. 4, 1866, p. 210.
4. Canadian News, Nov. 18, 1869, p. 325.

Seven refineries were listed as operating and their weekly capacity was given. One of the seven was said to be making a lubricating oil.[1] In none of the others is any lubricating product mentioned, presumably because they were making the usual illuminant and the only one worthy of special notice was the one doing something out of the ordinary: making a lubricant.

The Dominion of Canada Oil Refining Company attracted much attention in 1871 by its plan to use patent "processes for the manufacture of Canadian crude oil into burning oil, lubrication for machinery, railway and waggon grease."[2] The company continued to attract attention, but more from the failure, as the following of its plan. An agent, sent out from England by the English shareholders to investigate the management and operation, stated

> that the whole project was a swindle; that those who had invested their funds in it had been victimized; that the patent upon which it was intended to operate, and to convert crude oil into burning and lubricating oils of superior quality, and other products, was worthless; that there would never by a barrel of oil refined by the process, and that the works would have to be converted into something else.3

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1. Observer, July 20, 1871. Actually 8 were mentioned but one was incapacitated, the usual state of the so-called Mammoth Still of the Carbon Oil Company.

2. Observer, Mar. 31, 1871.

3. Observer, Nov. 15, 1872. Charges of fraud were eventually laid, see Observer, Dec. 13, 1872, April 4, 1873, April 11, 1873, and April 18, 1873.

Eventually the property and plant of the Dominion of Canada Oil Refining Company was ordered sold by the Court of Chancery, a familiar fate for many oil ventures. The upset price was not met,

> the machinery, made for the manufacture of lubricating oil under Howell's patents which did not realize the expectation of the inventor, accounted for the low bid.[1]

Canada's major market for oil was England. However, contrary to expectation, petroleum did not take England by storm. At a time when oil enthusiasts extolled the virtues of Canadian petroleum, many English technical men were apparently unaware of or not interested in its existence and potential. One of the leading British engineering journals noted:

> We have had several inquiries, which we are unable to answer, as to whether the lubricating petroleum, now so successfully used in the States, is sold in England. It would be well for engineers to experiment with some of the petroleum oils already in the market, although, if the results should prove unsatisfactory, it would only show that the proper quality of the oil had not been used. Of the success of the lubricating petroleum in America there is no doubt.[2]

The journal was unable to create an interest in petroleum lubricants. There followed no replies from indignant oil

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1. Observer, Mar. 18, 1877.

2. "Lubricating Petroleum," Engineering, II (Nov. 16, 1866), 365.

dealers - in fact there followed no replies - nor did this journal in the years examined, 1866-1875, have any comprehensive articles on petroleum lubricants. Petroleum was being used as a lubricant but its reception was slow and perhaps different from that expected by many.

Despite hopes to the contrary petroleum had to be mixed with other ingredients and could not be used alone as a lubricant. The Dominion of Canada Oil Refining Company was aware of this fact.

> They will make "a golden machine oil" of low gravity and free from parafine wax, which is to be used in mixing with lard, olive, sperm and seal oils, and it is claimed that these oils will be improved by the admixture of the petroleum lubrication. Railway wheel grease is to be made of the refuse.1

During the 1860s numerous sources pointed out that for all but the coarsest machinery, petroleum, crude or distilled, was best when mixed with fatty

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1. Observer, Mar. 31, 1871.

materials.[1] Those who expected petroleum to displace rapidly the animal and vegetable lubricants were slowly disillusioned. What was to take place was not a displacement but a union in which the earlier products were eventually reduced to the level of additives -- from major to minor but sill important components.

Understanding the role of petroleum as a lubricant is aided, as is so often the case in studying petroleum in Canada in the 1860s, by an accident report. In Hamilton

> ... the Round House ... at the Great Western Railway Depot .. was totally destroyed by fire. The origin of the fire was as follows: -- One of the workmen went into the shop to draw off some crude rock oil to be mixed with other oil for lubricating purposes, and having a light in his hand, the gas ignited and an explosion took place ... loss is stated at $15,000.[2]

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1. See for example: Canadian Native Oil, pp. 43, 46; Tate, Petroleum, p. 91; "The Flowing Wells," pp. 66-67. The best article from the 1860s on the production of lubricants from petroleum that I can refer the reader to is "Heavy Petroleum Oil," Manufactures for Upper Canada, VII (March, 1867), 75-76. In some cases crude was unmixed, see Canadian News, Oct. 30, 1862, p. 277, but I believe that this was a rather rare occurrence and became increasingly rarer. The article claimed that the Great Western Railway was using crude alone but the event referred to by the note below indicates they did not continue this for long.

2. Canadian Illustrated News (Hamilton), Nov. 7, 1863, p. 325. There were two newspapers calling themselves the Canadian Illustrated News. The one quoted is that published in Hamilton; it is extremely rare and almost totally ignored by historians.

In Canada during the 1860s and early 1870s, perhaps later, petroleum was used as a lubricant more frequently than it was sold as a lubricant. Many people bought crude or some distilled product not suitable for use as an illuminant and then mixed these with their other favourites in 'secret' recipes. One might also suspect that while petroleum was serving its apprenticeship in industry it was often an adulterant in more conventional lubricants. In spite of claims and predictions to the contrary it took many years before petroleum lubricants were widely known and openly accepted.

The Journal of the Board of Arts and Manufactures for Upper Canada proudly stated:

> There is no record in the commercial history of this or any other country in the world of a natural product or an article of manufacture becoming so generally known and appreciated in so short a period as petroleum.[1]

Statements such as these failed to take into account that one should not expect people, set in their ways, to change immediately upon the introduction of a new product.[2] One must also remember that no innovation is without its disadvantages and this was certainly the case with petroleum lubricants. During the early 1850s the first

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1. "On the Progress of the Petroleum Trade," Manufactures for Upper Canada, III (Aug., 1863), 247.

2. Canadian News, April 3, 1862, p. 219. Canadian News, Mar. 30, 1865, p. 198.

and only company in Britain importing petroleum in commercial quantities was Price's Patent Candle Company. In 1893 J. Veitch Wilson, author of Some Aspects of Lubrication,[1] was Chief of the Lubricating Oil Department of Price's. It is clear from his book that the acceptance of petroleum as a lubricant took considerable time and that petroleum was sold clandestinely without customer awareness.

> Instead ... of desiring to conceal the fact that Mineral Oils are used in the preparation of our oils, we particularly call attention to it, as we believe that, when blended judiciously with pure fatty oils of suitable quality, they enhance the value of these as lubricants, reduce their cost, add to their safety by reducing liability to spontaneous ignition, prevent gumming on machinery, and, to a large extent neutralize the chemical action which fatty oils exert on metals.[2]

Only once in the entire book did he mention using the petroleum oils without blending.[3] Hydrocarbon oil lubricants were widely used in steam engines by the 1890s and Wilson called

> for the exercise of technical skill and discretion ... in the selection of the most suitable oil and in its special preparation for the circumstances under which it is to be used.[4]

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1. J. Veitch Wilson, Some Aspects of Lubrication (London: Waterlow and Sons, 1893). [Hereinafter referred to as Veitch, Lubrication].

2. Veitch, Lubrication, p. 6.

3. Veitch, Lubrication, p. 32.

4. Veitch, Lubrication, p. 7.

Wilson realized that those advocating the use of petroleum lubricants had to consider the

> prejudices (the word is used in no offensive sense) and the habits of those who are responsible for the lubrication of the machinery.[1]

The prejudices were not entirely irrational as lubrication was more an empirical art than a predictive engineering science. There were many factors and properties to consider.[2] In the absence of both "rules" and adequate analysis and experience "the selection of oils for machinery" was filled with "difficulty and uncertainty."[3]

One example of some of the relative advantages and disadvantages to be weighed before turning to a petroleum lubricant is seen in the search for stainless textile oils. Oils for textile machinery were ideally ones which would not stain the textiles but no such oils were known and therefore one had to compromise.

> ... although it is admitted that ordinary mineral oils may be directly responsible for the discolouration of goods, and that even the finest mineral oils, when used alone, are difficult or impossible of removal, it must not be overlooked that, apart from the question of the permanence of the stains, mineral oils are less liable than fatty oils to produce the drops to which, when they are thrown upon cloth, the stains are due. For while mineral oils have no action

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1. Veitch, Lubrication, p. 18.

2. Veitch, Lubrication, pp. 19-32.

3. Veitch, Lubrication, p. 19.

> on metal, and keep spindles and bearings clean and free from gummy accretions, animal and vegetable oils, by their action on metal, and by their oxidizing tendency, inevitably produce the black drops of oil impregnated with metal which are periodically thrown on the cloth, and cause the ineradicable stains ...[1]

The decision as to which lubricant to use was not easy to make nor is it easy to make today. For the purpose of this thesis the essential point is that petroleum was not an immediate success. Eventually petroleum upstaged but did not eliminate other lubricants. The ways in which and the rates at which petroleum became the centre of the lubrication industry is an area of study which cannot be examined here but it is one which when thoroughly researched will reveal a great deal about machinery and bearing design and attitudes towards and knowledge of friction losses.

Along with its use as a lubricant petroleum also has a long history as a medicine. Throughout the period under consideration there are numerous general statements regarding its virtues in overcoming some of the many maladies on which quacks and medicine men made their 'fortunes'.[2]

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1. Veitch, Lubrication, pp. 39-40.

2. One of the great problems in dealing with the medicinal use of petroleum is that patent and nostrum medicines rarely listed their ingredients.

> Around the diggings, it is extolled as a specific for catarrh, coughs, rheumatism, and as a liniment for sprains and bruises.[1]

More specialized uses included "curing the itch" and "disinfecting the patient's clothes"[2] and serving as a pain killer in dentistry.[3] Montreal provided a good example of the enthusiastic optimism directed towards petroleum the medicine. In one Montreal hospital a special ward was established for the use and study of petroleum's medicinal values and virtues.[4] However, the medical observations that probably did the most for the petroleum industry were not those saying that petroleum did good but simply that it did not do harm.

> Mr. Forwood, a member of the Liverpool Dock Board, stated ... that he had visited several of the principal petroleum stores, and amongst them were some appropriated to the storage of Canadian petroleum, which it was known was of the most offensive character; but he passed through these stores with less inconvenience than he expected .... He was also very much struck with the appearance of a very stout man employed in gauging this petroleum, and he said that he slept well and ate well, and was anything but a proof of the injurious nature of petroleum.[5]

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1. Canadian Native Oil, p. 19.

2. "A New Use for Petroleum," Manufactures for Upper Canada, V (June, 1865), 163.

3. Canadian News, March 7, 1867, p. 148.

4. Canadian News, Sept. 4, 1862, p. 148.

5. Tate, Petroleum, pp. 104-105.

The use of petroleum as illuminant, lubricant and medicine bridged the gap between pre-commercial and commercial utilization of Ontario petroleum. As more attention was directed towards possible uses of petroleum many promising applications appeared.

One of the principal uses of petroleum today is as a fuel for engines: internal combustion, jet, and turbine, but not steam. It is true that by the 1860s there were internal combustion engines but these were largely experimental and peripheral, not to mention generally unsatisfactory. Petroleum, seen by many as a naturally produced coal derivative, was regarded as a coal and/or other bituminous substance substitute. One of coal's most important industrial uses was as a fuel in steam engines and it is not surprising that petroleum was used as a fuel to generate steam. Petroleum seemed to be the ideal fuel for Canada.

One need not have been a very acute observer of the colonial scene to realise that Canada had no coal: too many pointed out this sad fact of life. When commercial petroleum development started, most wished it were coal and not petroleum. England had coal but no petroleum to speak of. Canada had petroleum, no coal, and a fuel crisis. The "twin skeltons" in Canada's closet -- severity

of climate and lack of coal -- were largely responsible for Canada's rapidly depleting wood supplies with a resultant price increase.[1] Given these conditions one would expect to find differences in the reception given to petroleum in Britain and Canada.[2]

Some hope was expressed and various projects were undertaken to encourage the use of petroleum as a domestic fuel, primarily in the form of 'artificial fuel' made by mixing crude or refuse oil with substances such as clay of sawdust.[3] Petroleum was not the only 'innovative fuel' being tried; the 1860s witnessed considerable interest and investment in peat as fuel. The leader in the peat fuel movement was James Hodges, builder of the Victoria Bridge. Both movements trusted to economy and convenience to guarantee success and both had rather marginal success at best. There were no major reliable announcements of the success of peat and petroleum fuels

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1. Canadian News, Aug. 30, 1860, p. 131.

2. Canadian News, Jan. 23, 1868, p. 58. Canadian News, Mar. 12, 1868, pp. 180-181.

3. Canadian Native Oil, pp. 45-46.
Canadian News, June 5, 1862, p. 361.
Canadian News, Oct. 30, 1862, p. 275.
Canadian News, May 11, 1865, p. 295.
Canadian News, July 25, 1867, p. 51. A mixture of peat and crude petroleum is called for in this article.
Globe, Mar. 12, 1862.
Many more references could be given. Artificial fuel was a topic discussed a great deal in various European journals.

but there were complaints that with all of their oil Canadians still insisted on buying and using coal.[1]

Petroleum held the greatest promise as a fuel for military and industrial applications. The navy was most interested in the potential of petroleum as a boiler fuel but Canada had no navy. The navies of Britain and the United States considered petroleum a most promising fuel and investigated it. Britain, with no petroleum production, concentrated primarily on 'dead' or refuse oil while the United States turned mainly to crude. The advantages seemed overwhelming -- greater heat produced per unit of weight and/or volume with resultant increased range and/or space usable for other purposes, less time to get up steam, less fueling time, and fewer men were required because there was no need for stokers. The problems were, so it appears, greater than the advantages: greater expense -- a point for acrimonious dispute -- greater explosion and fire hazard potential, and above all greater combustion problems. It is also strongly suspected that vested interests and a general reluctance to engage in change in naval circles also played a not

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1. Canadian News, Sept. 17, 1868, p. 179.

insignificant role.[1]

In Canada, where there was no navy, it was as an industrial and non-maritime boiler fuel that petroleum was heralded. It was hoped that petroleum would be used as a fuel for metallurgical and metal working processes as well as a steam boiler fuel -- fields normally calling for coal or wood. Petroleum was to be the fuel of the future not only for working and fusing metals[2] but also for refining Canada's undeveloped iron and copper ores.[3] Very little came of either of these hopes.

Canadians were more interested in using petroleum as a fuel for steam engines but even here there was more interest than success. Some refiners used petroleum or petroleum residue as a fuel. There were probably many who tried the new fuel -- petroleum --

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1. Many experiments and articles were produced as a result of interest in the use of petroleum as fuel. All of the journals of the 1860s and 1870s consulted while researching this thesis had articles about the topic. A good but far from comprehensive starting point for research is J. D. Barnett, "A Partial Bibliography of Petroleum," Transactions of the Canadian Society of Civil Engineers, I (October to December, 1887), 45-47.

2. "Oil-Lamp Furnace for Fusing Metals at a White Heat," Manufactures for Upper Canada, IV (Oct., 1864), 302-303.

3. Canadian News, Aug. 30, 1866, p. 131.

and at least one who tried the two new fuels -- peat and petroleum -- mixed.[1] The generally mixed success of attempts at using petroleum as a fuel is best typified by the results of two separate trials. Gartshore, a machinist in Dundas, failed while the firm of Smith and Robertson succeeded.[2] The basic problems were those of economy and convenience, the former in particular being dependent upon a great many factors.

> The experiment of burning petroleum has been abandoned for the present, at least at Mr. Allen's mill here ... the question to be decided there was the question of economy in using petroleum as a steam generator .... A week's use of the paraffine crude oil has shown that from five-sixths of a barrel to a barrel of the fuel is required per hour to drive a forty horse-power engine, and this is considerably more expensive than wood at $3 per cord ... the inventors are by no means convinced that they cannot compete with wood at the price named. In the oil refinery and in Mr. Robertson's foundry, the petroleum is still used, and still deemed cheaper than wood at Guelph prices ... the engines of these places are twelve horse-power and about two gallons per hour continue to drive them satisfactorily....
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> The failure of Mr. Allan's mill is ascribed mainly to the form of the fire-box and to the arrangement of the tubes or flues of the boiler. The patentees claim that a very large proportion of the caloric is wasted and Mr. Allan tells me that he intends to have his boiler altered so as to economise fuel, even in burning wood. The

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1. Canadian News, July 25, 1867, p. 51.

2. Canadian News, Dec. 19, 1867, p. 387.

flues are straight, running directly from the fire-box to the smoke-stack, without returning through the boiler. The alteration Mr. Allan proposes, and one which the patentees of the petroleum injector think will entirely alter the conditions of the comparison between wood and petroleum as fuel, is the affixing of elbows to the tubes or flues of the boiler, so that the heat will pass from the fire-box to the rear end of the boiler, thence return to the front, and again pass through the flues to the smoke-stack. In this way the flame will be brought in contact with a much larger heating surface and far less of it escape up the smoke-stack. When we take into consideration the distance through which the flame of the burning petroleum will travel, there is no doubt that a very great saving can be effected in this way ....

.... when the combustion of the fuel is going on favourably, the smoke from the smoke-stack is almost imperceptible; but very frequently during the experiment in Mr. Allan's mill, large volumes of dense black smoke issued from the stack, showing that a large proportion of the carbon of the oil was passing off unconsumed. Elongation of the flues, or the addition of the elbows to convert them into return flues, will have a tendency to correct this difficulty .... Another fact, which Mr. Robertson has noticed, is that his foundry when the petroleum is supplied a little more rapidly than usual, the smoke-stack becomes heated to a red heat, demonstrating on enormous waste of caloric in that direction. These are incidental defects which can doubtless be remedied, if no other or greater difficulties are developed.

So far as I can learn here, no trouble has been experienced from the clogging or obstruction of any part of the apparatus by the refuse matter of the oil. In fact, the machinery is so simple that there is not much which liable to get deranged... the injecting tubes, steam pipes, retort, &c., all work in a perfectly satisfactory manner. Mr. Allan finds but two objections, one of these the increased cost as compared with wood; and the other, the smell arising from the oil. This latter might become a serious one in a flouring mill .... Another difficulty that has been experienced in some attempts

> at using petroleum as a steam generator is the obstruction of the flues or tubes of the boiler by the refuse of the oil after burning. Careful inquiry here fails to detect any trouble of this kind. The engines at the refinery and at the foundry have been driven for some time with the petroleum, and no such trouble has been experienced. On the contrary, the patentees claim that the flues are cleaner than when wood or coal is used ... the engineer has very decided objections to the disagreeable smell, and to the grease and dirt inseparable from handling the oil, and prefers wood for these reasons alone ....
>
> .... The petroleum injector is a success, so far as the simple burning of the oil is concerned; it may yet prove that oil should supersede wood and and coal as fuel, where the former is abundant and the latter can only be obtained at high prices from the cost of transportation, limited supply, or any other causes.1

The most highly publicised experiments using petroleum as a steam boiler fuel were those conducted in search of an economical railway locomotive fuel. With no native coal in Ontario or Quebec and low-priced wood on railway lines becoming rarer some thought petroleum might be a fuel as well as an item of freight. As in most of their dealings with petroleum Canadian railroads could be counted on for more rhetoric than action. With the opening of the Great Western Railway branch from Wyoming to Petrolia in late 1866 T. Swinyard, General Manager of the Great Western, gave an encouraging after-dinner talk.

> With regard to oil production and the various uses to which the rich mine of wealth may be

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1. Canadian News, Jan. 30, 1868, pp. 69-70.

> turned, I may inform you that the mechanical superintendent of the Great Western Railway, at my instigation is now making extensive experiments to bring about the use of oil for consumption in our locomotives. I am perhaps a little premature in making the announcement 1

Initial experiments with oil as with peat were extremely encouraging[2] and yet the whole project slowly sank out of sight.

Petroleum did not make it as a boiler fuel. Newspapers, journals, and most significantly the patent records show no lack of interest but they do point to difficulty in obtaining efficiently useful combusion, a problem not uniquely Canadian. For clean efficient combustion an essential was much oxygen thoroughly interspersed with the 'atoms', i.e. fine particles or droplets, of petroleum. Very frequently this was not accomplished or when it was with machinery so complex as to be financially and/or mechanically unworkable. The Canadian patent records indicate a number of approaches to the problem. The simplest was merely an open basin filled with burning crude and fanned by an air blast.[3] It was also possible to convert petroleum to a vapour outside the boiler and then

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1. <u>Canadian News</u>, Jan. 17, 1867, p. 37.

2. <u>Canadian News</u>, Jan. 10, 1867, p. 17.
   <u>Canadian News</u>, Oct. 29, 1868, pp. 282-284.

3. Canada Patent Number 2273.

pipe it to the boiler surface with a flame spreader -- a necessity for long boiler life in the design being referred to.[1] Most of the patents were variations on one main theme: vapourization and ignition within the boiler (fire-box) aided by one or more of forced air, steam, superheated steam, and the heat provided by the burning of the petroleum vapourized.[2]

But technical problems were not the only block to the use of petroleum as a railroad fuel. Conversion to petroleum from wood or coal was neither easy nor cheap and was justified only if petroleum proved a cheaper fuel. The problem was that no one could be sure that petroleum would be cheaper. Prices and production fluctuated and no one knew how long the supply would last. There was also the additional problem that petroleum was only produced in one part of Canada whereas local wood and ballast coal were available 'locally' in many areas.

As a major market for petroleum its use as a fuel was a failure. On a lesser level, primarily locally and in specialized but low demand uses, petroleum met a need.[3]

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1. Canada Patent Number 2268.

2. Canada Patent Numbers 2127, 2218, 2294, 2337, 2434, 2465, 2477.

3. For an example of the use of petroleum in the fusing of metals see "Oil-Lamp Furnace for Fusing Metals at a White Heat," Manufactures for Upper Canada, IV (Oct., 1864), 302-303.

During very difficult times the small markets helped to keep the petroleum industry alive. However, it was the major markets that the oil industry was most interested in.

Petroleum promised large quantities of illuminating gas without the need for coal. An examination of Canadian patents reveals the hopes and the methods of the faithful.[1] It is possible to look at the basic methods without careful scrutiny of the equipment. The simplest plan was simply a retort in which the petroleum was to be heated, vapourized and then presumably burned immediately[2] -- a patent in a class by itself for simplicity, vagueness and unworkability. Much of the 'gas' produced would condense upon cooling to normal temperatures, a most unsatisfactory and potentially dangerous situation. Another of the simple processes was merely to bubble water (or its vapour), air or illuminating gas through petroleum or a product of petroleum thereby producing an illuminating gas or enriching a pre-existing

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1. See the following Canadian Patents: 1216, 1344, 1345, 2000, 2143, 2145, 2158, 2392, 2618, 2690.

2. Canada Patent Number 1297.

illuminating gas.[1] However, a more sophisticated approach was needed. Little hope was put in the above. Systems had to be designed to operate at sufficiently high temperatures to give a 'fixed' gas, i.e. one which would not condense at normal temperatures.[2] The gas produced would then be mixed with that from other sources, either water or wood. Of the various Canadian patents granted during the 1860s for producing gas from petroleum none attracted as much attention as numbers 1344 and 1345, granted jointly to James E. Thomson, gas engineer, and Henry Youle Hind, a Toronto professor of chemistry and geology. The patents were for

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1. See for example Canada Patents 2143, 2145, 2158, 2392. See also "New Application of Rock Oil," pp. 286-287; "On the Carburation of Illuminating Gas by Purified Petroleum, and on the Manufacture of Gas From the Crude Petroleum of Canada and the U.S.," Manufactures for Upper Canada, II (Jan., 1862), 1-4. [Hereinafter referred to as "On Illuminating Gas"]. The Canadian News, Nov. 19, 1868, p. 326, points out the dangers of using that terrible product gasoline to produce an illuminating gas by bubbling the gasoline through water. For a scathing indictment of the dangers of storing gas and air mixed and of mixing them anywhere other than the point of combustion see "Mr. E. B. Shears on Petroleum Gas," Manufactures for Upper Canada, III (Jan., 1863), 5-6.

2. See Canada Patents 1344, 1345, 2618, 2690.

An Apparatus for the Manufacture of Illuminating Gas from Crude Petroleum, or Rock Oil.1

and

A process for the Manufacture of Illuminating Gas from Crude Petroleum or Rock Oil.2

The Thomson and Hind process offers a good example of the initial enthusiasm and apparent success followed by disillusionment and abandonment that is characteristic of many projects using petroleum during the 1860s. The process was the subject of numerous articles praising its economy, safety, and odour-free bright light. It was used in various hotels, inns, and factories and the recipient of glowing testimonials.[3] 1862 was a very good year for the Thomson and Hind process and 1863 promised to be even better as the process, equipment and product

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1. Canada Patent 1344.

2. Canada Patent 1345.

3. Canadian Native Oil, pp. 38, 43.
Tate, Petroleum, pp. 48, 49.
Canadian News, Jan. 3, 1862, p. 6.
Canadian News, April 17, 1862, p. 249.
Canadian News, May 8, 1862, p. 293.
Canadian News, June 19, 1862, p. 393.
"On Illuminating Gas," p. 4.
"Petroleum Gas," Manufactures for Upper Canada, II (Sept., 1862), 272.
"Petroleum Gas - Stevenson House," Manufactures for Upper Canada, II (Oct., 1862), 304.
"Petroleum Gas - The St. Nicholas Hotel, New York," Manufactures for Upper Canada, II (Dec., 1862), 360-361.

were in such demand that a company was being formed[1] and then no more is heard. Hind, professor of chemistry and geology, stayed in the news and published, Thomson did neither.

The Thomson and Hind equipment was designed to give private establishments their own physical plant for gas generation, a move contrary to the then prevailing system of centralized production and distribution to a number of customers. Established gas companies were not interested in decentralization but this is not to say that petroleum failed to attract their interest. Gas works in a number of Upper Canadian towns and cities made experiments and trials with petroleum. Initial experiments were very encouraging and therefore followed by full scale commercial utilization of petroleum as a source of illuminating gas.[2] The result was a product satisfying neither customers nor coal interests and subsequent abandonment of the project.[3]

As a source of an illuminating gas petroleum was not a resounding success and the reasons are not clear but include the uncertainty of supply, deodorizing problems, fear of petroleum and a prejudice that was slow to die.

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1. <u>Canadian News</u>, Jan. 22, 1863, p. 52.
2. <u>Canadian News</u>, July 10, 1862, p. 21.
3. <u>Canadian News</u>, Sept. 11, 1862, p. 164.

But if the prejudice did not die neither did the hope. In 1875 in Lambton County Ribighini and Anderson were still working on making a gas from petroleum[1] and in 1885 one of the promises of the fraudulent but promising Alpha Gas, Oil and Refining Company was a cheap gas.

> The starting of this enterprise in our town will be of great advantage in the way of fuel and light. Fuel, which is so largely consumed eight months of the year ... when gas can be had for burning purposes at one dollar per thousand feet, and at twenty five cents per thousand feet for heating purposes, it will be seen how advantageous it will be. The reason gas can be supplied so cheap it that by the new process, it requires but 4 per cent of carbon to 96 per cent hydrogen and nitrogen obtained from waste to make a first class gas for heating and illuminating purposes. It can, therefore, be supplied to manufacturers cheaper than coal; and as an instance of this we might mention that in Pittspurg, Pa., natural gas is supplied at twenty cents per thousand and it is used in preference to coal at $1.50 and $2.50 per ton. With coal here at $6.00 per ton and heating gas at twenty five cents per thousand the saving can easily be imagined.
> The oil to be manufactured is on the same economical principle, as three barrels will be made out of the one of crude, and it will be free from sulphur and other elements which make our oil so much inferior to the American.[2]

Petroleum did not live up to its initial promises as a source of an illuminating gas but there were other promises.

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1. Canadian News, Nov. 18, 1875, p. 837.

2. Observer, June 5, 1885.

During the 1860s and therefore coinciding with the oil boom in Canada the most exciting developments in industrial organic chemistry were those in the aniline dye field. In Canada developments in organic chemistry did not go unnoticed and in this connection one name stands above all others: Hugh Nixon Shaw. Shaw was not the only one who believed that aniline, or benzine to synthesize aniline, could be extracted from petroleum.[1] However, not all were in agreement that aniline dyes could be produced from Canadian petroleum and the leader of the opposition was Professor Croft who strongly opposed the optimistic Professor Hind.[2] There is reason to believe that at least one dye was produced.

> The Canada Company employed for some time, a chemist, in the hope that he would be able to produce dyes. He did to some extent; and a very fine and beautiful blue, which he produced, is exhibited at the refinery. But he unfortunately

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1. For an introduction to Shaw see Globe, Sept. 12, 1861. Globe, Sept. 2, 1861, and Globe, Mar. 12, 1862. For other expressions of a belief that aniline dyes could be or had been produced from petroleum see any of the following. Canadian Native Oil, p. 38, Oil Districts, p. 7, Canadian News, Nov. 9, 1865, p. 292, Canadian News, June 14, 1866, pp. 374-375, Canadian News, Jan. 17, 1867, pp. 36-37, and "The Oil Wells in Enniskillen," Manufactures for Upper Canada, II (Feb., 1862), 61-62. The Canadian News, May 11, 1865, p. 295 refers to a red ink made in Hamilton from petroleum but gives no details as to how it was made.

2. Canadian News, April 10, 1862, p. 233.

died, and his invention was lost with him.[1]

In his description of the Canada Rock Oil Company at Oil Springs Alexander Somerville noted that

> in the earlier operations at this refinery the coal tar, instead of being re-distilled for oil as now, was submitted to a different chemical treatment in a laboratory which we see close by. Crystals were obtained by the chemical process and used in dying textile fabrics .... The operating chemist at this laboratory died. The company have not yet found another. Hence the laboratory is silent and the coal tar of the petroleum stills instead of being transmuted to brilliant dyes to add to the splendour of the dry goods emporia, is re-distilled to obtain from it the last possible extract of illuminating oil.[2]

There is nothing to indicate that during the 1860s petroleum became a major source of aniline dyes but there were other ways to use petroleum as a colouring matter. The tarry residue remaining after distillation could be and was used to produce a heavy black paint, particularly good for metal,[3] and also to produce a leather blacking.[4] Most of the petroleum products used in paints and varnishes were not used as a colouring agent. The lighter cuts of petroleum, those generally known as benzole or naphtha, served admirably as paint oils, carrying the pigment and then evaporating giving the

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1. Oil Districts, p. 7.

2. Canadian News, June 14, 1866, pp. 374-375.

3. Montreal Herald, Oct. 22, 1862.

4. "Petroleum Blacking," Manufactures for Upper Canada, V (August, 1865), 217.

same end result as would linseed oil or turpentine.[1] The reasons for petroleum's use in this manner are twofold. The first is that there was a very conscious search for uses for petroleum and its products. The second was that it worked and was cheaper than turpentine or linseed oil, particularly during the American Civil War years.[2]

There were other uses for petroleum. Petroleum was said to be "well adapted" "for the fabrication of mastics and cements."[3] The patent record indicates its use as a wood preservative[4] and an unidentified newspaper

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1. Canada Patents, 1409, 1993, 2807.

2. For further information see any of the following:
Canada Patents: 1409, 1993, 2807.
Globe, Sept, 12, 1861.
Free Press, Jan. 27, 1859.
Spectator, Mar. 10, 1862.
Montreal Herald, Oct. 22, 1862.
Globe, Mar. 12, 1862.
Canadian Native Oil, p. 19.
Tate, Petroleum, pp. 81-82.
Canadian News, Oct. 17, 1861, p. 148.
"Alex S. Macrae's Circular for September," Manufactures for Upper Canada, II (Oct., 1862), 320.
"Lubricating Petroleum as a Siccative Oil," Manufactures for Upper Canada, VII (June, 1867), 157.

3. See Appendix B. The same report says that the petroleum is "admirably adapted for illuminating purposes.

4. Canada Patents, 1342, 1695, 2492.

article in the Smith Collection states that as early as 1851 Henry and Charles N. Tripp turned to the petroleum resources of Lambton for "asphalt to seal ship hulls."[1]

By the end of the 1860s much had been learned about petroleum products and their marketability. During the earlier part of the decade petroleum was widely regarded as the source of an almost unlimited number of products and applications. The utilization of petroleum, a 'new' and exciting material, was the subject of much healthy and enthusiastic but unrealistically optimistic speculation. In contrast with the great expectations, petroleum appeared to deliver very little. However, when viewed in the context of the technological sophistication and chemical knowledge of the day, petroleum delivered a great deal. The industry matured very quickly and concentrated on the production of an illuminant, the only product that could give the mining, refining, and marketing of petroleum the stable base that it needed. Other uses and products continued to play a minor but not insignificant role. The minor

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1. Smith, S29-16. I have found no other references, reliable or otherwise, to the use of petroleum products in sealing ship bottoms.

uses provided little in terms of immediate economic returns but held out the promise that, by combining better knowledge in a number of fields with more thorough and patient research, petroleum could supply many products and fulfil many needs. The first decade of the petroleum industry in Canada often appears to be the disappointing tale of profligate and dissipated youth. It was in fact a period of a somewhat chaotic but nevertheless rewarding search for direction and stability.

CHAPTER V

STORAGE OF PETROLEUM

As a commercial product petroleum was new to Canada. Before petroleum could be successfully extracted from the ground, processed, and marketed it was necessary to modify existing and to create anew processes and equipment. There was an acute need for innovation in the storage of petroleum. Storage problems were uniquely critical because, unlike other Canadian minerals, petroleum was mined, transported, and sold as a liquid rather than a solid. The result was that there were serious leakage problems which had to be solved. The problems of leakage and the general need for new processes and equipment gave the Petroleum Boom in Canada a uniqueness which it shared with no other Canadian mining booms.

It is easy to overlook the uniqueness because Lambton displayed the normal social and technological signs of a mining boom. Lambton was filled with men who laboured under seemingly intolerable conditions and lived in crowded filthy quarters. Their lives were brightened by visions of wealth and the visits of 'ladies' who had been advised that although the greasers smelled to high heaven

they had dollars. The oil men were living and engineering from crisis to crisis, producing hurried half-solutions and jerry-built structures based on spur of the moment thinking. Much of their work, although clever and well thought out, was ruined by sudden and unpredictable changes: storms which the foundations were not strong enough to weather. The problems encountered in storing oil and their solutions provide an excellent example of what might be termed normal procedure in the development of oil technology in Canada. Out of the many false turns and starts a workable technology emerged.

As might be expected the earliest means of storage was also the most primitive. There are many ways to look at a surface (dug) well. First and foremost it is a means of getting crude oil. Second, if constructed as such, it is a means of 'controlling' the composition of the product in that it should keep out surface and ground water and if it is constructed in such a fashion then it is also, by virtue of its nature, a storage area. "Enniskillen Blue" (Erie Blue Clay) is the tenacious clay 'goo' responsible for much that was said about bad roads in Enniskillen. When the Enniskillen Blue was puddled into

the space between the cribbing and the natural sides of the dug well the well was made virtually impervious to water coming in through the sides.[1] It should be evident that a well does not provide adequate storage; there are limitations on capacity but even moreso it limits production because most wells of this type would partially fill naturally and the oil level would stabilize. It was only when oil was pumped out that more petroleum would flow into the well.[2] In some instances the wells were not so well-behaved and although not gushers did overflow and were out of control.[3] It is worthy of note that when this happened in one instance the first line of defence was merely to increase the volume of the well, i.e. the container; "the clay which had been taken out in digging was piled up to the depth of fully four feet."[4]

After leaving the well the oil would ideally be barreled for shipment. When the Lambton oil boom began

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1. Water might come up through the bottom of the wells and in at least one instance oil, under extreme pressure, burst through the walls of the well. See Smith, S25-19, July 19, 1860.

2. Globe, Aug. 9, 1861.

3. The Globe, Aug. 30, 1861, says that this was a fairly common occurrence. See also Globe, June 25, 1861.

4. Smith, S25-20, July 19, 1860. It is the Underhill well that is being referred to; when storage capacity was exhausted the oil ran into the creek.

there was not a cooperage in the area, a fact noted and commented upon by many of the visitors who after one visit became experts on 'things oleaginous' and predicted that anyone opening a cooperage would have many customers and make a considerable amount of money: they were right and wrong. Eventually cooperages were established; eventually, because as with so much during the early years of oil industry announcements and promises went unfulfilled and projected completion dates were extremely elastic.

By February of 1862 the town of Black Creek (Oil Springs) had a cooperage turning out 1,000 barrels per week.[1] Wyoming was also listed as having coopererages or coopers' shops by January of 1862[2] but these were probably small low-production hand shops. Continuing optimism in the barrel market is reflected in the announcement that the 150 barrel per day factory of Messrs. Sanborn and Co. was to be ready for operation "about the first of July"[3] 1862.

Storage problems continued even after the establishment of barrel factories. The barrels leaked, they

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1. Leader, Feb. 12, 1862. See also Canadian News, Mar. 6, 1862, p. 151.

2. Globe, Jan. 8, 1862.

3. Observer, May 20, 1862.

could not be produced as fast as needed and the demand was built on rather shaky foundations.

In January of 1863[1] the flowing wells stopped flowing and many thought that the oil industry was finished; it was not; pumping was the answer but with both crude and refined grossly over-produced the oil fields remained rather quiescent for two years of "unfortunate stagnation."[2] Early in this slump the coopers had no illusions as to what this could mean for them.

> On our way we passed a number of refineries and coopers' shops. The owners of the latter till lately have had more orders for oil barrels than they could fill in time to meet the demands of their customers; but the demand is dying away, and they have fears that it will cease altogether ere long; a couple of months or so will tell whether their fears have any foundation or not.[3]

Their fears were well-grounded. For two years there was no real call for barrels. When the petroleum industry in Lambton recovered barrels were again in demand and in short supply.[4] The revival in demand came too late for two enterprises which, with heavy investments in machinery, had been formed for the large scale production of barrels.

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1. The best discussion of the cessation of flow is in the Times, Sept. 1, 1865.

2. Times, Sept. 1, 1865.

3. Canadian News, April 16, 1863, p. 243.

4. Canadian News, Oct. 5, 1865, p. 345.

The enterprises

> came to nothing -- or rather to heavy losses to the proprietors. The barrels could be made and were made, but there was no oil to put in them, and they were not wanted. As in the case of the refineries, the whole of the immense expenses had been incurred, and parties committed to the enterprise, ere it was suspected that the oil supply was about to fail. I can only add, as in the case of the refiners, that the business push and the energy of the men who went into the undertakings in question, was well worthy of a different result.[1]

It was unfortunate but such were the results of playing the lottery.[2] Good times would and did come again as would more barrel makers. The oil industry needed barrels that were not expensive and did not leak. Oil penetrated the wood much more readily than other liquids and therefore the barrels leaked more when storing

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1. Times, Sept. 1, 1865.

2. The oil business was very frequently referred to as a lottery. See, for examples, any of: Robb, "Petroleum Springs," p. 316, Globe, Feb. 7, 1861, Canadian News, July 3, 1861, p. 5, and "Petroleum Wells of Pennsylvania," Manufactures for Upper Canada, III (Oct., 1863), 305. The Observer, Mar. 30, 1866 informed its readers that "One fifth of an acre in the rear of the famous O'Grady well, opposite the Oxford house, which sold for $2,500, is now set up as a lottery at $1.00 a chance. It was a surface well but a derrick and engine has now been erected on it."

petroleum than with other liquids. The demand for oil barrels fluctuated and to succeed barrel manufacturers had to cope with this problem. However, barrels alone, important as they were, were only part of the answer to the storage problems.

That oil barrels were expensive there is little doubt; $2.00 per barrel was the customary price in 1862[1] and remained so throughout the 1860s. Had the barrels not leaked the price might have been somewhat more bearable but in the early years of the oil boom leaking barrels were the rule rather than the exception. Leaking barrels help to account for some of the reluctance that railroads and shipowners had about handling petroleum.[2] The history of the early years of the petroleum industry in Canada West is filled with stories or anecdotes similar to the two which are to be given here.

> A party engaged in the oil business forwarded to New York 1,000 barrels of oil by rail in March last. On its arrival there, he had to pay $20 for cooperage, and lost 300 barrels out of the 1,000 by leakage during its transit by the cars; and had transit to New York taken place in warm weather, the loss would certainly have been greater.[3]

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1. Globe, Mar. 12, 1862.

2. The reluctance is seen in refusal to handle oil, a position frequently taken by shipowners, and by the high rates charged by the railroads.

3. Canadian News, June 5, 1862, p. 354, based on a report in the Sarnia Observer.

> A vessel which carries one load of petroleum is fit for no other business save coals, iron, timber, or other articles which cannot be spoiled by the odour. The Great Western Railway has had to pay for several car loads of flour which was spoiled by being carried in vehicles which some time before had contained oil; and it is said that a miller, having incautiously allowed a sample barrel of the stuff to enter his mill, had his flour sent back by his customers, on account of the flavour which had been communicated to it.[1]

Tate (1863), in discussing the bad odour which emanated from stored petroleum and gave it a bad name identified the culprit not as the oil but the barrels, "leaky casks and other unsuitable vessels" which allow it to leak out, the loss in some instances being "as much as 25 per cent."[2] Once a ship or a railroad car had been used for petroleum, particularly crude, it could not be used to ship products whose resale value would be lowered by having absorbed the odour of petroleum.

There were many reasons why the barrels leaked: part carelessness and part inherent with the materials involved. When the oil boom started producers had to take whatever they could get and undoubtedly many of the barrels used were of extremely poor workmanship and never intended to hold anything as valuable or as liable to leak and

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1. Canadian News, April 3, 1862, p. 219.

2. Tate, Petroleum, p. 104. Tate does not mention glued barrels.

leave destructive tell tale marks as petroleum. Undoubtedly many leaked not only because they had been put together poorly but also because in the rush to make barrels they were made of green wood. Oil could pour or trickle out of cracks between ill-fitting staves or through green staves but even in well made barrels oil could be absorbed into and work its way through tightly fitting staves of good wood. Oil was an unusual product requiring special measures. One of the measures was simply using the most suitable wood. Unfortunately most suitable did not equal most readily available. Pine and oak were the woods commonly used; Lambton county was covered with beautiful oak forests but was virtually devoid of pine. Pine staves were less permeable than oak but were more expensive and more difficult to obtain.[1]

One way to deal with leaking wooden barrels was not to use them but rather to use metal containers. As early as 1862 this was proposed for use in Canada but to no avail.[2] In England a Mr. Cope got somewhat further

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1. For a short description of barrel-making machinery and a discussion on the merits of oak and pine see "Home Manufactures - The Eastwood Barrel Factory," Manufactures for Upper Canada, III (Aug., 1863), 248.

2. Canadian News, Oct. 30, 1862, p. 279.

as he patented and apparently produced a few of his Patent Iron Drums[1] but the idea never really made any impact in the 1860s.

Wooden barrels had to be improved, not abandoned. One of the most radical proposals for preventing oil seeping through the pores of the wood was to make a pressboard or laminated pressed wood barrel.[2] The barrels never went into production. Another unimplemented suggestion was that hermetically sealed barrels could be produced by acting in accordance with the dictates of nature. "The impermeability of the wood is accomplished by having the annular layers concentric in the package as they are in the tree" rather than by "cutting the annular rings

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1. Tate, Petroleum, pp. 97-98.

2. The barrel was described as being "made of thin slips of wood, similar to shavings, and laid up in the form of cylinders; the slips crossing each other at right angles and running around a certain portion of the circumference of the barrel in a spiral manner, and fastened with glue and water-proof cement .... Hoops were not necessary to hold the barrel together, but in some cases hoops were fastened to the inside circumference to strengthen it where much rough usage was anticipated." See "Staveless Barrels," Manufactures for Upper Canada, VII (Mar., 1867), 79.

in lengths equal to the thickness of the staves."[1] There were other proposals, some of which were satisfactory.

The most acceptable solution to the problem of leaking oil barrels, albeit not a completely satisfactory one, was rather simple. Good oil barrels leaked when the oil impregnated and soaked through the pores of the wood. The problem was rectified by coating the inside of the barrel and impregnating the wood with a glue which was not petroleum soluble. The earliest Canadian patent for such a process is that given to Otto Rotton of Kingston in 1866.[2] However, there is more substantial evidence that glue coated barrels were used for storing and transporting oil in Canada as early as 1863.

One of the potentially valuable but as yet untapped sources for the history of technology in Canada West in the 1860s is the scattered writings of Alexander Somerville on industry in Canada. One of his articles deals with the mechanized production of barrels at

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1. "Hermetic Barrels," Manufactures for Upper Canada, V (Feb., 1865), 53.

2. See Canada Patents, numbers 1968, 1969. 1970, 1976, 2060, 2110. Dr. Rotton, a Doctor of Medicine, seemed to be quite fond of amassing patents relating to the petroleum industry. I have not found a description of his plant or any evidence as to whether or not his processes were successes or failures or even if they were ever implemented.

Eastwood on the Great Western Railroad line four miles from Woodstock, the line leading to Wyoming. Here, barrels "intended for the reception of coal-oil are charged with a glutinous compound, that is by steam forced into the pores of the wood ...."[1] Unfortunately, Somerville has not described the process other than to say that it is dome by steam. Based on an account of how barrels were coated and impregnated in Pennsylvania it is probably safe to say that the function of the steam was to heat the wood and/or act as a carrier for the injection of the glue.[2]

The glue impregnated barrel was often referred to as the cemented barrel but whatever the name it represented the height of wooden oil barrel technology throughout the 1860s. For example, in one of the many articles suggesting solutions for the ills of the Canadian oil industry the cemented barrel played a central role. The proposal to establish in London, C.W. "a joint-stock company for the purpose of manufacturing, by a new process, an entirely deodorized oil and air-tight cemented

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1. "Eastwood Barrel Factory," p. 248.

2. Canadian News, Oct. 10, 1867, p. 228, describes the impregnating of barrels with glue by pressure in Titusville.

barrel in which to ship it" was greeted with laudatory remarks.[1] The cemented barrels were not perfect but were the best at the time. However, barrels were expensive and, cemented or uncemented, had a maximum capacity of about forty gallons. Barrels could not be manufactured locally in sufficient numbers to stay abreast with the wildly fluctuating demand should they be the major means of storage. The boom or bust nature of the barrel business is illustrated by the fact that in spite of increased productive capacity the local supply was not enough, and during 1862 barrels had to be imported, 3,000 coming in one shipload.[2] However, in 1863 there was not enough work for the coopers.

In part, the scarcity and expense of barrels turned the oil men to other means of storage.

> ... 24 round tanks capable of holding 130 barrels each, and 3 square tanks, capable of holding 600 barrels each, have been built and are nearly full. The well owners have adopted this expedient to save expense, it being far cheaper to store oil in large tanks than to pay $2.00 for 40 gallon barrels.[3]

There were also other factors responsible for this

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1. Canadian News, Aug. 30, 1866, p. 131.

2. Observer, Sept. 12, 1862.

3. Globe, Mar. 12, 1862.

transition, namely space and convenience. Barrels took up far too much room especially at a crowded well site in the bush. Pumping from well to barrel is more difficult and requires more constant attention than pumping from well to storage tank and then filling barrels as the need arises. For all of the reasons discussed the large storage tank soon became an integral part of the oil well and storage depot.[1]

Bulk storage facilities were very quickly constructed at the well heads, centralized depots for a group of wells, and at depots on transportation arteries, the latter being the largest. The tanks were of the in-ground or under-ground as well as the above ground type and made of wood and/or metal. Wood was more popular because it was easily worked and readily available at a lower price than metal.

The earliest underground tanks were usually square or rectangular and of very simple construction: "pits sunk in the stiff clay, cribbed and puddled".[2] The size varied considerably and many reporters spoke of them

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1. If one sees the earlier surface wells as being both source of oil and means of storage, then the large tanks underground may be seen merely as a displacement and an enlargement of a part of the well.

2. <u>Globe</u>, Aug. 30, 1861.

being large, small, i.e. in rather uninformative terms, or, as in the case of the twenty vats at Kelly's wells "about the size of a small log house".[1] A reporter who visited the Canadian oil region in the late summer of 1861 was more precise. The smallest dug tank that he mentions is one capable of holding 120 barrels and made at a cost of $50.00.[2] Using $2.00 barrels the same storage capacity would cost $240.00. A tank twelve feet in diameter and twenty-five feet deep was also under construction.[3] This tank would have a capacity of about 17,600 gallons.

Returning to square tanks it is to be noted that

> Mr. Sanborn built the largest tank in Oil Springs. It is 20 feet square and 17½ feet deep. Being sunk in the ground it is puddled a thickness of 3 feet, and will hold 1,250 barrels, or 50,000 gallons. Two teams are employed in drawing to it oil derived from the Blila well.[4]

Covering the tanks seems to have been optional and one description gives not only technical information but also some insight into daily life in the oil regions.

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1. *Observer*, May 31, 1861.

2. *Globe*, Sept. 6, 1861.

3. *Globe*, Sept. 6, 1861.

4. *Globe*, Sept. 6, 1861. The well referred to was a flowing dug surface well.

> Huge vats are occasionally constructed but holes dug in the ground, well puddled and cribbed with large balks of timber are more generally used. The oil evaporates very quickly and the proprietors seem very careless about it and in many cases do not even take the trouble to place a few boards over it. The stench from these huge reservoirs of oil is very offensive, especially when they are being filled. It smells something like a compound of onions and gas tar, and though the residents of the place profess not to dislike it, it well-neigh poisons a stranger. The oil appears to have penetrated everything about the place. Water taken from the wells is most nauseous. Folks in Toronto desiring to get a slight idea of its flavour will step up to the pump on College Avenue by the side of the flag staff and take a drink. The other day a boy, five years of age fell into a surface well. About two feet of oil floated on the top of the water, and buoying up the poor little fellow, the father was enabled to reach him. When taken out he vomited a great deal of oil, but sustained no injury from it, and was a few hours afterwards running about as well as ever.[1]

Some underground tanks were covered and as time went on they became more the rule, partly because open tanks were more of a fire hazard.[2] In 1862 one of the larger tanks in Victoria (Oil Springs) was covered with the result that the loss of oil and the odours emanating from it were less than from the uncovered although it was not completely free of these problems. It was

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1. Globe, Sept. 6, 1861.

2. The Canadian News, June 25, 1868, p. 467, in describing a fire indicates that there were open tanks still being used.

described as a "large hole dug in the earth, about 40 feet square, covered with 2 inch plank, and made rain-tight, the inside is lined with six inch square logs, behind which clay is puddled two feet thick to make it oil-tight as well as water-tight; the depth is about 16 feet." To this description a warning was added: " ... you must take care when you open that 3 feet square trap door in the centre of the covering, or the rush of gas will almost suffocate you."[1]

Not all of the underground tanks were square or rectangular, some were round. One round tank has been mentioned.[2] Another article refers to oil from a round well seven feet in diameter;[3] in the same article it was mentioned that oil and water were being pumped into an above ground circular tank. While newspapers and other written sources indicate the existence of round wooden tanks, both above and below the ground, they do not adequately describe construction methods.

Two photographs, plates I and II,[4] which were taken

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1. Globe, Jan. 8, 1862. Later tanks were not puddled for two as puddling less than that is sufficient.

2. See above or Globe, Mar. 12, 1862.

3. Globe, Sept. 6, 1861.

4. The photographs were formerly owned by the late Col. Harkness, former Gas and Oil Commissioner for the Province of Ontario, and are now held by W. D. Brittain, Chief Inspector, Petroleum Resources, Department of Mines and Northern Affairs.

in the early or mid 1860s give some insight into the construction of above ground wooden storage tanks. Of the two photographs, one of the Lick and one of the Pepper well, the latter is the most informative. The Pepper well photograph shows four circular tanks which are of a height of seven to eight feet and with diameter slightly larger than the height. The upper diameter is smaller than the lower, the sides tapering in at an angle of approximately five degrees. The tank is made of upright boards four to six inches wide and of unknown thickness; the boards are encircled by horizontal bands or hoops, presumably iron, about twelve to eighteen inches apart. This general description also fits an engraving of the Noble Wells at Petrolia.[1] There is no reason to believe that the description is not representative of many of the tanks. There is also no reason why this method of construction should be changed substantially for below ground construction nor why it should differ substantially from round cribbed wells.

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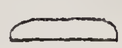
1. "Oil Wells of John D. Noble, Esq., at Petrolia, Ontario, Canada," Canadian Illustrated News, Feb., 11, 1871, pp. 83, 84. The former page is descriptive, the latter the engraving which does not completely fit the description.

In an oil well near Aylmer, Ontario, which was abandoned in 1865 the similarity between storage tank and well construction is clearly evident.[1] The surface portion of the well was dug and cribbed in a circular fashion with a seven foot diameter. The cribbing is of horizontal planks 4½ inches wide, 1 3/4 inches thick with bevelled ends tapering to a thickness of 3/4 inch over a distance of 4 3/4 inches. The purpose of the bevelled edges is to allow the depth to be increased by the addition of further planks without using structurally weak butt joints. The banding had partly rusted away and so little more can be said other than it was not all one piece but made of a number of pieces rivetted together with 1/4 inch diameter rivets at 3 inch centres with a total overlap of 6½ inches. The bending iron was 1 3/4 inches wide and 7/16 of an inch thick with a  cross-section. Similar construction would have been used in a round storage tank.

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1. For further information see David Hall, "Dropped Money Down Hole in Elgin Boom," London Free Press, Dec. 24, 1971, p. 26. I am not at liberty to divulge further information about the location of the well. The dimensions given in my thesis do not agree with those in Hall's article. Hall's dimensions are estimates. My measurements were taken by my brother Gary R. Ball and I when we visited the site with Messrs. David Hall and Bob Sherman. They were recorded and checked at the well site.

A tank might have been only as deep as the length of a stave but could be made deeper by using a bevelled lap joint which is simple to make and reliable.

One of the problems pacing storage tanks and some detail on their methods of construction is found in the following.

> THE BEST TANK YET! -- The secerity of the weather will doubtless put to the test many of the ground tanks, and not until the frost is entirely out of the ground will holders of oil feel perfectly safe. It may then be discovered that a few cents per foot extra might have saved considerable loss. This remark suggested itself upon noticing an excellently constructed ground tank at the Blackburn well, the rings of which being only about half the usual distance of eight inches apart. The storing capacity is something over 3,100 barrels, and for excellence of finish this tank, we think is unsurpassed, and justly entitles the contractors, Messrs. Campbell and Kinnon, to the medal.1

The rings are probably the iron bands or hoops encircling the tank and designed to keep it tight and rigid, a function that is extremely important in an area subject to frost heaving.

Further variety in the methods of underground storage tank construction is found in a report which I cannot match with a date or source other than Lauriston's Lambton's Hundred Years (1949) in which he says that he is quoting an article "published many years ago".

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1. Canadian News, Feb. 20, 1868, pp. 116-117.

> These underground tanks ... are circular in form and can be dug to any required capacity, the Erie clay of the district being especially adapted to the purpose .... The clay is so compact and impervious that it will hold oil or water without leakage.
>
> In excavating a tank, expert workmen trim down the walls with their spades until they become smooth, and when the hole is dug out they commence at the bottom and ring it up with solid wooden rings. These rings are formed of kants, which are pieces of Canadian pine cut in this form of a segment of a circle, and shaped just to fit the circular well of the tank. They are from three to four feet long, five inches wide, and one inch thick, and as one man proceeds to nail them together and ring up the tank, another follows him, putting on the next piece so as to cover the joints, and so on until they ring up the tank to the top. When completed it is a pretty sight to behold.
>
> This wooden lining is put in to prevent the clay from caving in, but not to stop leakage, as the clay holds the oil perfectly. These tanks have been known to hold oil for ten years without leakage. Another great advantage of this system is that the oil is kept at an even temperature and that there is no danger from lightning, which has caused so many disastrous fires in other places to oil stored in large iron tanks.
>
> These tanks for storing the crude oil are usually dug thirty feet in diameter and sixty feet deep, and hold about 8,000 barrels of 35 imperial gallons to the barrel. The upper 20 feet of the clay is not so impervious as the lower part. So the blue clay is taken from the bottom of the tank and puddled about one foot thick behind the wooden lining, in the upper 20 feet, thus forming a perfectly oil-tight tank. It is then covered with tar paper between, and a coating of gravel on top.[1]

Underground tanks, especially when covered, were the

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1. Victor Lauriston, Lambton's Hundred Years: 1849-1949 (Sarnia, Ontario: Haines Frontier Printing Company, n.d.), p. 180. [Hereinafter referred to as Lauriston, Lambton]. The method of construction is unusual and I do not know if it was used during the 1860s.

least liable to become fire hazards and were commonly found in refineries for the storage of crude and refined.

To this point nothing has been said to indicate that the storage tanks were anything but permanent stationary installations and with the wooden underground tanks this was no doubt the case. Although the evidence is rather scanty there is some to suggest that some above ground tanks were portable, particularly those which were relatively small. In a report on one of the many fires which plagued the oil regions the following appears:

> ... we found Mr. Grey's tank of oil on fire. It burned with amazing fury and being close to the derrick endangered the building. The boys around proceeded with alacrity to haul off the tank from the vicinity of the derrick, and after sometime succeeded in spilling the contents, upsetting the burning vessels and quelling the flames.[1]

This, while far from the largest, was no small tank as the loss is given as fifty barrels.[2] Whether this tank was on wheels or runners is still a matter of

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1. *Observer*, July 13, 1866.

2. *Observer*, July 13, 1866. Much of the early equipment seemed to be rather portable and therefore probably quite small. The *Observer*, Oct. 31, 1862, reporting a fire in one refinery notes that it spread towards that of Messrs. Bush but "the refinery of Messrs. Bush pulled down to prevent the spread of the flames."

conjecture but it seems highly probable that it was provided with one or the other in order to facilitate movement in the event of fire or if the well should go dry and the tank be needed elsewhere. In an account of the Shaw gusher (1862) it is reported that "empty tanks were borrowed in the neighbourhood, and they too were speedily filled."[1]

Excluding for the moment all tanks but those at the well head, some were designed to do more than simply store oil. Most if not all of the wells produced an oil and water mixture[2] which would separate or settle into two layers. In at least one instance two tanks were used, one above and one below the ground. Water and oil were pumped into the former and the oil ran off into the latter after time was allowed for separation.[3] Since all or almost all of the wells produced water and oil in varying proportions, separating arrangements were universal. It was necessary to draw the oil off the top and drain or pump away collected water.

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1. <u>Leader</u>, Jan. 22, 1862.

2. The <u>Observer</u>, Feb. 6, 1863 tells of a well whose daily production was "about 10 barrels of oil" and "upwards of 100 barrels of water".

3. <u>Globe</u>, Sept. 6, 1861.

While this chapter is intended primarily to look at the means of bulk storage one event in the early years of the oil region should be mentioned: the Shaw gusher of January 1862. Although the Shaw and subsequent gushers did not directly lead to any new developments in storage they did give dramatic evidence of the need for storage capacity on a large scale; they also supply some idea as to what could be pressed into service in an emergency.

The early settlers who scooped up small quantities of oil set their own pace in gathering oil. It could be skimmed from stagnant pools of water or from small holes scooped in the ground. They gathered it when they needed it and were not forced to handle the excess. With dug surface wells the oil collected in the hole dug and again could be removed at a pace set by the workmen with no necessity to remove and store the oil. With the advent of the gushers and flowing wells a whole new dimension was introduced. A gusher spews out oil uncontrollably, thus setting the pace at which the oil is to be stored if it is not to run to waste. Once controlled, a gusher will often become a flowing well and is theoretically completely under control so far as retarding the rate of

flow is concerned. In fact, it was not quite so simple because it was felt that stopping the flow completely might mean that it would not start again or if it did start again it would be at a reduced rate of flow.[1]

When the Shaw gusher came in all available resources were pressed into service but were insufficient to prevent great waste. " ... conductors were laid to adjoining wells which were soon filled with oil, barrels were procured -- they were filled; empty tanks were borrowed in the neighbourhood, and they too were speedily filled" as the well "vomited forth a sufficient quantity of oil to submerge the vicinity to the depth of several inches."[2] Had the creek not been frozen the oil would have followed the course of some subsequent gushers and floated down the creek and eventually made its way to the Sydenham and St. Clair Rivers.[3]

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1. <u>Observer</u>, Jan. 24, 1862.

2. <u>Leader</u>, Jan. 22, 1862.

3. John D. Noble tells how he became involved in the oil industry. "I came here about 1866. The way my attention was first called to the business was this: I was a vessel owner residing at Kingston. A schooner came back covered with oil and I asked the captain what was the cause of it. He said they had struck oil at Sydenham and could not stop the wells from flowing, and that it was coming down the river a foot thick on top of the water. I considered there might be something in it, so I came here immediately to look into the matter. What the captain referred to was caused by the flowing wells at Oil Springs ... I fancied the place and bought some land." See <u>Commission on Minerals of Ontario</u>, p. 159.

The gushers and the generally increased productivity, particularly after the 1863-65 slump, combined with the tendency of the oil industry to become somewhat more stable and concentrated in the hands of fewer but larger firms and individuals meant that storage facilities expanded throughout the 1860s and 1870s. Along with the increase in total capacity some changes in construction methods. In the early 1860s tanks, both above and below ground, were primarily made of wood and in the case of below ground storage this proved to be very satisfactory. There are puddled wooden tanks still being used in Lambton county which predate the memories of those living near them. Wooden above ground tanks were less popular than the below ground puddled clay and wooden tanks because the former besides creating more of a fire hazard leaked too much.[1]

Above ground wooden tanks were more susceptible to the ravages of the elements, fire included, and were supplemented and then replaced by boiler plate tanks. The earliest mention of a metal component, other than for hoops or banding, in storage tanks in the Canadian oil regions was made in October 1861. This was a tank "above the surface made of timber and inch boards, lined

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1. Canadian News, Sept. 11, 1861, p. 85.

with zinc., and perfectly tight."[1] As well as being expensive, this type of tank would have been little or no better than the puddled and cribbed underground tanks and no more is heard of metal tanks until 1867. In 1867 F. Bechell and Co. of Hamilton were "erecting iron tanks to hold crude at Petrolia"; they were of 1/4 inch boiler plate, the largest, twenty-two feet high and fifty-seven feet across, to hold 10,000 gallons.[2] Earlier in the same year, in Petrolia, a 5,000 barrel iron tank twenty-two feet in height and forty-one feet in diameter was being constructed.[3] It is clear from the account that it is the largest tank to date and perhaps the first of its type in the area. The step in this direction seems to have been taken at the request of one company and not to have started an immediate rush to above ground iron tankage because in June 1867 Petrolia had only 15,000 barrels of iron tankage, the property of

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1. Canadian News, Oct. 31, 1861, p. 185.

2. Observer, Mar. 29, 1867. These were made so as to hold six inches of water on top and it is fair to assume that this is a precaution against fire.

3. Canadian News, Feb. 14, 1867, p. 98.

Mr. David McLean's Petrolia Oil and Tank Co.[1] However, progress in this direction continued and by 1873 the "prodigious iron tanks" were a characteristic and noteworthy feature of Petrolia's "suburb of Pithole".[2] By 1880 the pendulum had swung away from above ground iron tanks. Belden's Lambton Atlas of 1880 notes that in Petrolia

> the tanking of crude oil is now all underground. The practice was formerly to store it above ground in huge iron tanks. The Iron Tanking Co., of Boston, have yet two immense iron tanks standing, out of a large number formerly in use, the balance having been utilized principally in the construction of tank cars for the shipment of crude in bulk over the railways.3

The trend from barrels towards bigger storage units was encouraged by and brought into creation one of the specialized trades found in the oil fields: the oil

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1. Canadian News, June 6, 1867, p. 362. The Canadian News, Nov. 21, 1867, p. 327 gave the total "iron and ground tankage" as 212,000 barrels. The Canadian News, Jan. 16, 1868, p. 36 gave 234,000 barrels as the "aggregate tankage completed, including iron and ground." The Observer, April 16, 1869 gives the amount of oil in storage at 320,000 barrels.

2. Observer, July 4, 1873. The tanks were connected to each other and to the wells by iron pipes 1½ inches in diameter and up to one or two miles in length.

3. Quoted in Lauriston, Lambton, p. 179. I have not seen the Atlas.

tank builder.[1] However, there was also a need for smaller, high quality, easily handled and stored containers for shipping refined oil. By shipping refined, a finished product, in small high quality durable containers the oil need not change containers from refiner to final consumer or at least to retailer. It was for this reason that after having good reason to believe that the deodorization problem had been beaten or at least subdued to an acceptable level, refined was shipped from Petrolia and other refining centres to the European market in five and ten gallon cans which were not as leaky, messy, or dirty as wooden containers and yet were far less fragile than glass. This method of storing and transporting oil was being taken seriously as early as 1869 when a tin factory was established in

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1. I do not know when the building of oil tanks first became regarded as a trade in itself. An article in the Smith Collection, undated but from the Sarnia Observer, contains the reminiscences of a Mrs. Samuel Stokes as well as some information about her husband. "Mrs. Stokes came to Petrolia in 1869 at the age of 20 years and has since lived here. In 1871 she was married to Samuel Stokes, a well-known builder of underground oil tanks, who was also active in the construction of the Sarnia tunnel." From internal evidence it would appear that the article was written some time in 1939; the article is to be found in my files as Smith, S23-23.

Petrolia to turn out five and ten gallon cans. The money for this venture was coming from the Canada Land and Mining Company, owners of a refinery in Petrolia.[1]

By the end of the 1860s satisfactory solutions to the problems of storing petroleum had been arrived at. Something akin to standard storage practice had emerged from an apparently chaotic period in which Canadian oil men successfully struggled with a member of technological problems, one of which was how to store an offensive smelling but valuable liquid. The means of storage are impressive for their effectiveness and simplicity. When necessary resources and technological sophistication are rather limited, as they were in the Canadian oil fields during the 1860s, it is a great accomplishment to produce engineering that is both simple and effective.

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1. Observer, April 16, 1869.

CHAPTER VI

SOURCES OF PARTS, MATERIALS AND EQUIPMENT

Much of the present exploration and drilling for oil in Canada is being carried on in rather remote and inaccessible areas. The logistics problems thus created are severe but in some respects less so than those faced in the oil fields of Canada West in the early 1860s. Much of the equipment presently being used benefits by being based on years of experience as well as being made by specialists. The result is that the probability of breakdown is small and in such an event standardized interchangeable replacement parts minimize down time. When considering logistics problems, distances should be measured in units of time. When distances are measured in this manner Oil Springs in 1861 might be further from Buffalo than the Arctic Circle from Petrolia in 1972. Viewed as an exercise in logistics obtaining necessary parts, material and machinery involves far more than merely making and buying them. One of the essentials is a good transportation network and this the Lambton oil fields did not have, particularly during the first half of the 1860s. The oil men were no different from any others whose aim is to produce a

well-run continuous industrial operation. Expressed very simply, the oil men needed a constant and reliable source of parts, materials and equipment.

When steam pumping and drilling was started in Enniskillen in the winter of 1860-61 the mere feat of getting a steam engine into the virtually inaccessible oil fields was cause for considerable surprise.[1] This feat had been accomplished by sledding the engines and boilers in during the winter. The state of the roads at other times of the year made sledding in winter the only feasible approach. Transportation facilities played a crucial role in the availability of steam power. By April, 1863 a forty horsepower engine made by John Gartshore of Dundas was being used in the oil fields.[2] Moving such a large engine and boiler into the oil fields was a major project and would have been almost if not completely impossible if the plank road into the oil fields had not been completed.[3] It was well known that engines were more expensive at Oil Springs or Petrolia

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1. Canadian News, Sept. 11, 1861, p. 85.

2. Canadian News, April 16, 1863, p. 249.

3. I have been unable to find any figures for the weight of a forty horsepower engine but the Oil Well Supply, pp. 11-13, lists the weight of a 15 horsepower drilling engine and a 15 horsepower boiler as 2500 and 4000 pounds respectively.

than at Bothwell[1] because the latter had far better transportation facilities even though somewhat lacking in oil. In 1865 the steam saw mill at Bothwell was powered by a forty-five horsepower engine,[2] probably the largest in the oil region and one which would have been more difficult and far more expensive to put in Oil Springs than Bothwell.

Steam engines had to be 'imported' into the oil fields. From the newspapers and journals the picture of a rather thriving steam engine industry in the Canadas in the mid 1860s emerges. The Canadian steam engine industry met almost all of the steam power needs of the oil industry although not always as quickly as the oil men's erratic demands might wish. Direct references to the use of American engines are few. There is one reference to engines from Buffalo[3] and one to engines from Erie.[4]

On the other hand, there are more numerous references to engines from Canada with documentation to indicate that

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1. Canadian News, May 18, 1865, p. 314.

2. Canadian News, May 11, 1865, p. 295.

3. Free Press, June 25, 1861.

4. Globe, Sept. 2, 1861. The report stated that the engine from Erie, a six horsepower engine, "cost in Erie $450., boilers and all complete." The Oil Districts, p. 19, gives the prices of the eight and twelve horsepower portable steam engines as $550" and "$840 or $850" respectively. It is not known if this price included boilers.

they were being made in and coming to the oil fields from Brantford,[1] Hamilton,[2] Dundas,[3] Oshawa,[4] Guelph,[5] Toronto,[6] Chatam,[7] and Montreal.[8] The Brantford manufacturer was C. H. Waterous and Co. Engine Works. By 1864 Waterous had been manufacturing steam engines for fifteen years and their largest engine was for drilling and pumping wells.[9] Engines from Hamilton came from the shop

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1. Canadian News, Oct. 14, 1864, p. 229.
   Canadian News, May 18, 1865, p. 316.

2. Canadian News, May 18, 1865, p. 316.
   Canadian News, May 25, 1865, -. 326.

3. Canadian News, April 16, 1863, p. 249.
   Canadian News, May 18, 1865, p. 316.
   Canadian News, May 25, 1865, p. 326.

4. "The "Joseph Hall" Agricultural and Steam Engine Works, Oshawa, C. W.," Manufactures for Upper Canada, V (Dec., 1865), 312. [Hereinafter referred to as "Hall Engine Works"].

5. Canadian News, Jan. 4, 1866, p. 1.

6. Canadian News, Aug. 10, 1865, p. 88.

7. Canadian News, Nov. 16, 1865, p. 314.

8. Canadian News, Feb. 28, 1867, p. 132.

9. Canadian News, Oct. 13, 1864, p. 229.

of Beckett and Co.[1] while those from Dundas were the work of Gartshore,[2] a very active and seeming first class machinist, founder and engine builder verv much deserving considerable study. Montreal seems to have had several "engine-makers" whose "machinery was occasionally met with" in the oil regions. The machinery of "E. Gilbert, Canada Engine Works, Montreal" had attracted Alexander Somerville's notice and was "spoken of in terms of praise" by men in the oil fields.[3] Unfortunately, it is not known how many engines these men produced although it seems to be no small number. In 1864 Waterous and Co. were reported to "have manufactured steam-engines, within a few years amounting in value to over $400,000.00."[4] The supplier and manufacturer from Oshawa - The Joseph Hall Agricultural and Steam Engine Works - also appears to have been involved in no mean operation as along with other orders they were engaged in "manufacturing not less than ten portable steam engines, of from fifteen to

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1. <u>Canadian News</u>, May 25, 1865, p. 326.

2. <u>Canadian News</u>, May 18, 1865, p. 316.
   <u>Canadian News</u>, May 25, 1865, p. 326.
   <u>Canadian News</u>, April 16, 1863, p. 249.

3. <u>Canadian News</u>, Feb. 28, 1867, p. 132.

4. <u>Canadian News</u>, Oct. 13, 1864, p. 229.

twenty horse power each, destined for the oil regions."[1] Steam engine producers were benefiting by the oil boom. By August of 1865 engines were arriving at Bothwell at the rate of three, four or five per week.[2] Less than half a year later it was stated:

> No less than 125 steam engines have been delivered by the Great Western Railway at the village of Bothwell for the purpose of sinking wells. This represents a sum of probably $200,000, expended among Canadian mechanics in a single branch of labour connected with the wells of one district. We do not know how many engines have been sent into Enniskillen, since they have gone in by various routes, but we fancy we are safe in saying that the machinery of all the oil districts of Canada must be of the value of $500,000.[3]

Many of the engines used for sinking wells would also have been used for pumping. Little is said about the origin of the pumps. The simple suction pumps used in some surface wells, some of which were hand pumps, were probably of local manufacture but it is not known for sure. To produce the more complex force pumps needed for wells much over thirty feet deep requires nothing that a steam engine manufacturer could not make and yet curiously there

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1. "Hall Engine Works," 312.

2. Canadian News, Aug. 24, 1865, p. 120.

3. Canadian News, Jan. 4, 1866, p. 6.

is no evidence that they branched out into this line; perhaps it was riskier than making steam engines for the oil men -- the engines could be used for many other purposes if the demand by the oil men dropped but pumps would not sell as readily. In the 1864-65 County of Lambton Gazetteer Clark Curtis of Sarnia is listed as a turner and pump maker[1] but one man could not meet the needs of the industry. In the spring of 1865 it was noted that "the pumps are very liable to break down" and that "Lick's well, which was pumping at the rate of 50 barrels per day, has been at a stand-still for three days for want of a valve, which cannot be procured nearer than Buffalo."[2] There were some attempts at producing sophisticated equipment locally but these ventures were not successful. Mr. Lick's wait for his valve underscores and important point: the oil regions depended heavily upon outside sources for vital equipment, the reliability of which was important but not always present.

Breakdowns were frequent and could be costly as

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1. Lambton Gazetteer: 1864-65, p. 86. Because he was called a "turner and pump maker" we might therefore suspect that his pumps were of wood and not suitable for deep oil wells.

2. Canadian News, May 18, 1865, p. 316.

well as annoying. There is no scarcity of examples of breakdowns and subsequent loss of time and money. Mr. Lick was 'losing' fifty barrels of oil per day for want of a valve. But at least Lick had a pump; others were waiting for a pump[1] so that later they could wait for it to be repaired. Sometimes people did nothing because they were waiting for engines[2] and sometimes they waited for repairs -- ten days seems to be a long time to be held up by a broken engine shaft.[3] To helplessly watch oil run to waste while waiting for pipe to come from Buffalo must have been a particularly agonizing experience.[4]

Much of the equipment was unreliable but the oil men were not without fault and were often criticized for their gross negligence of equipment.[5] The result of this human failure was more frequent mechanical failure than was necessary and the search for a mechanical rather than

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1. Canadian News, Oct. 26, 1865, p. 262.

2. Globe, April 12, 1861.

3. Canadian News, Aug. 24, 1865, p. 123.

4. Smith, S27-6, letter of Jas. B. Bennett, Oil Springs, Aug. 10, 1862.

5. Canadian News, Oct. 26, 1865, p. 262.

a mechanical and humane solution. Greater respect for the machinery would have helped to relieve some of their problems.

But basically what was needed was a good local source of parts and repairs, the latter being particularly important because with the great variety of equipment and methods in the early 1860s it was far too much to expect to have parts depots that would supply all that was needed. To meet the demand for parts and repairs, foundries and blacksmiths shops were needed and were provided.

As early as 1856 Wyoming had a blacksmith shop as well as a steam sawmill, steam gristmill and a brickyard,[1] all of which were probably on a very modest scale. The new status of Enniskillen and Wyoming is reflected in the announcement (June 1861) that a Mr. Richardson of Ingersoll was constructing a foundry in Wyoming which was to employ twenty-five or thirty hands.[2] When finished[3] it was described as a foundry and machine shop.[4] The following year Oil Springs had reason to be proud of its

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1. Free Press, Sept. 10, 1856.

2. Canadian News, June 19, 1861, p. 199.
Globe, Mar. 12, 1862.

3. The Globe, Aug. 30, 1861, mentions a "fine foundry just into operation" in Wyoming, it is probably Richardson's.

4. The Canadian News, Oct. 31, 1861, p. 185, speaks of the foundry as owned by Richardson of Ingersoll.

facilities as it could boast of "3 blacksmiths, 1 foundry almost completed, 1 tinsmith" and a number of others such that they had "all the trades."[1] Undoubtedly there were more blacksmiths in the area than three. The Lambton Gazetteer: 1864-1865, credits Oil Springs with five,[2] Sarnia nine,[3] and Wyoming two[4] blacksmiths.

After the unfortunate ecnomic stagnation of 1863-64 oil was again all the rage, with Bothwell the centre of excitement if not of oil. With the fever came the usual break-downs, delays and frustration as well as the pleading wish-statement that:

> There is a fine chance both at Bothwell and Oil Springs for a practical mechanic, with a little capital, to set up in business, holding himself in readiness to do repairs and to supply the parts belonging to the machinery used, which, as many of them are all of one pattern, would be easily done.

But that was not all as the article ended with a simple but important sentence: "Mr. Gartshore, of Dundas, is about to open a branch of his works at Bothwell, having purchased land for the necessary buildings."[5] Gartshore's

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1. Leader, Mar. 18, 1862.

2. Lambton Gazetteer, pp. 100, 106, 109.

3. Lambton Gazetteer, pp. 84, 89, 90, 92.

4. Lambton Gazetteer, p. 120.

5. Canadian News, May 18, 1865, p. 316.

word was good and a "foundry and machine shop"[1] was set up. Gartshore's shop was "adjoining the blacksmithing and waggon shop of Mr. Luke", a shop which along with others in "Bothwell ... Chatam, London, Brantford, Dundas, Hamilton, Oshawa, and other places throughout the province"[2] helped to meet the needs of the oil industry in the Bothwell region. Bothwell was not the only centre of activity. Oil Springs was favoured with a branch of E. E. Gilbert's Montreal machine shop.[3] Petrolia, soon to surpas Oil Springs, was the site of a "large machine shop and blacksmith shop"[4] with "4 bellows."[5] The oil regions of Canada West still had many setbacks and problems to face but the absence of foundries, machine and blacksmiths shops was not to be among them. The difficulty in obtaining and maintaining parts and equipment was lessened not only by the establishment of foundries, machine and blacksmiths

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1. Canadian News, Sept. 7, 1865, p. 156.

2. The Canadian News, Sept. 7, 1865, p. 156 mentions that "Mr. Gleghorn, well known in this country, is to have charge" of Gartshore's shop.

3. Canadian News, Jan. 18, 1866, p. 39.

4. Free Press, Feb. 21, 1866.

5. Canadian News, Mar. 22, 1866, p. 187.

shops but also by increasing standardization.

By the mid 1860s the oil fields were fortunate enough to have the shops of men such as Gilbert and Gartshore and were also witnessing a greater conformity and standardization in methods and equipment. In the same year that Gartshore opened his shop in Bothwell, the Bothwell Reporter, after reviewing the reasons for the great delays experienced in well-sinking and why, once sunk, many had a rather short life, was

> most gratified to learn that a company is in course of organization which will meet all the difficulties we have mentioned. A uniform size of well will be decided upon, and suitable tools, piping, castings, and all other materials connected with well-sinking will be kept constantly in store, so that anything required may be duplicated at an hours notice.[1]

Although oil practice standardization was far from complete it was enough that entrepreneurs such as John H. Fairbank could advertise "every variety of oil fittings, heavy and shelf hardware" as well as "groceries and provisions, wines and liquors."[2] Merchants could make their contributions to relieving the logistical and standardization problems without a major capital investment. Other contributions required large amounts of capital.

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1. Canadian News, Oct. 26, 1865, p. 262.

2. Quoted in Victor Lauriston, "McGarvey of Petrolia Became World Figure in Oil," Smith, S29-1. In the Observer, June 8, 1866, J. Parker and Co., an Oil Springs firm, advertised tin and well tubing.

In the oil fields the large operators did all that they could to deal with the problems of logistics and standardization. Those who could afford to strove for and achieved vertical integration of their operation as a means of ensuring uniformity and minimizing dependence upon others. Vertical integration of the oil industry was a means of bringing about technological integration. In the oil fields this approach to the problem of obtaining machinery, parts, and materials occurred while many of the pioneers, "working men in the possession of a few hundred dollars" with "primitive and cheap machinery", were being ousted; the "territory" was "rapidly being absorbed by large capitalists" and few of the original proprietors remained.[1] One example of large scale and comprehensive organization was the Wyoming Rock Oil Company, capitalized at $1,000,000.[2] Wyoming Rock Oil enjoyed the advantages that money could buy.

> Owing to their extensive plant they are enabled to work at a much less cost than they would if their operations were carried on on a more limited scale. The tools which do for making one well, do also for others. They make their own barrels, their own tanks, have their own blacksmiths

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1. Canadian News, May 4, 1865, p. 279.

2. Canadian News, May 4, 1865, p. 279.

> and carpenters, and, except when they have to purchase their steam engines elsewhere, are self-dependent.[1]

They also had their own distillery with a weekly capacity of seventy-five barrels but this was far below the productive capacity of their wells.[2] In the same category with respect to technical sophistication and self-sufficiency was the Canada Rock Oil Co., financed by Mr. David Torrance of Montreal.[3]

The large companies were influential but there were still many small operators owning the basic equipment and owning or leasing well sites. These men patronised the private blacksmiths or foundries for jars, drills, bits, castings of various kinds and other equipment which would be made and maintained locally. Depending upon the style of drilling and pumping used they would depend upon the previously mentioned Fairbank or "J. Parker and Co."[4] for 'imported' pipe, tin and well tubing, some of which, if of the 'scotch' variety might be made locally. Their lubricants would probably be of their own or local manufacture and their fuel was local wood, natural gas,

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1. Canadian News, May 4, 1865, p. 280.
2. Canadian News, May 4, 1865, p. 280.
3. Canadian News, June 14, 1866, p. 375.
4. Observer, June 8, 1866.

oil, or oil refuse. Wood was cut locally, and although at one time burned because it was cheaper than oil, was "rapidly disappearing" as big companies cut their way through the forests to meet their fuel needs. "One firm alone during the winter -- the Wyoming Rock Oil Company -- cut 3,500 cords of wood and are still at work."[1] Wood was much more than a fuel.

Wood was also the primary structural material for everything from roads to oil tanks, derricks, and wagons.[2] Wyoming had a steam sawmill by 1856 but it burned in 1860, a not unusual occurrence for sawmills. The need for lumber was met by the lumberyard of a Mr. Oliver, formerly of Ingersoll,[3] and the itinerant sawmill of Mr. Elliott; the latter played an important role in linking Oil Springs and Wyoming with a plank road. Elliott's Mill, known locally as "Mount Elliott, although ... situated in a black ash and elm swamp", could get the job done by cutting

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1. Canadian News, May 4, 1865, p. 279.

2. The importance of wagons should not be underestimated in an area whose immediate environs lacked rail connections until late 1866 and never had water connections. As early as 1861 the Free Press, June 25, 1861, noted that Wyoming had wagon makers and it is likely that many wagons were locally made and repaired.

3. Free Press, June 25, 1861.

at the rate of "one thousand feet per hour."[1] Elliott seems to have been a rather unsavoury character or perhaps just a shrewd businessman trying to stay alive in dire straits. He was not exceptionally popular but did make a good impression on the saddlebag Methodist preacher Robert Burns.

> The chief proprietor here is Col. Elliott, formerly Mayor of Cornwall, whom I had known of old, and who came to both of our meetings. He is a religious man, and although a Congregationalist, is very friendly to us. He is the proprietor of the plank road between here and Wyoming, (15 miles) and makes the staves for the oil barrels, many of which passed us on the road on Friday.[2]

In turning to the production of staves Elliott was showing good business sense. From 1860 to early 1863 barrel production was below the demand. It was reported in May 1862 that "one large steam barrel factory will shortly be commenced" in Oil Springs with another "in contemplation" giving a total manufacturing capacity of "over 7,500 barrels per day."[3] The report is overly optimistic. Even if the reporter meant per week instead of per day he was still high and should have said per

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1. <u>Canadian News</u>, Oct. 31, 1865, p. 185. The mill at Bothwell was reported by the <u>Canadian News</u>, May 11, 1865, p. 295, as being able to cut 20,000 feet per day but it is not known how long the day is. Elliott's mill often was worked 24 hours per day.

2. Undated letter in Smith collection, <u>Smith</u>, S27-43.

3. <u>Canadian News</u>, May 22, 1862, p. 330.

fortnight thereby leaving himself open only to a charge of slight exaggeration.[1] However, wood was not the only building material; bricks could be and were produced locally.[2] But putting up buildings was only part of the job; they had to be used and for refineries this meant supplying them with sulphuric acid.

Sulphuric acid was not being produced in Canada at all when the oil boom started although the raw materials were present. In a lecture entitled "Canada as a Field For Chemical Manufactures" Professor Bell of Queen's University pointed out that no chemical manufacture could be carried on more profitably in Canada than that of the production of sulphuric acid, an acid which Canadians had imported nearly $80,000.00 worth in 1863.[3] The following year Alexander Somerville noted that the "sulphuric acid used in deodorising the oil is brought a long distance at much cost, some from New York, some from Liverpool." He urged that it be produced locally.

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1. The evidence for total production is not clear but at the most and assuming no duplication of reports one might get a figure as high as 2,800 barrels per six day week. See Leader, Feb. 12, 1862, Spectator, Mar. 10, 1862, Observer, Mar. 20, 1862, and Globe, July 24, 1862.

2. Free Press, Sept. 10, 1856, Leader, Mar. 18, 1862, and Observer, Oct. 13, 1862.

3. "Canada as a Field for Chemical Manufactures," Manufactures for Upper Canada, V (June, 1865), 157-158. The production of aniline dyes was encouraged in the same lecture.

because "its crude elements abound at Oil Springs, as at all places where petroleum exists" and "in refining oil the expedients of genius and instincts of economy will soon appropriate the local acids, to the exlusion of the more costly imported articles now in use."[1] The proposals fell on deaf ears for a short time but there were others who felt that if the acid could be manufactured in Canada it should be. It seemed rather absurd that iron pyrites should be sent from Brockville to New York to be made into acid to be sold in Canada[2] and an application was made for a charter to incorporate the Dominion of Canada Chemical Works Company to manufacture sulphuric acid at Brockville, capital $50,000.00.[3] But this was not the first positive response to the need for sulphuric acid; on "21st May, 1867" the "first sulphuric acid plant in Canada was opened in London C.W."[4] It should have come as no surprise; there was a clear need

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1. Canadian News, June 14, 1866, p. 375.

2. Canadian News, June 6, 1867, p. 361.

3. Canadian News, June 20, 1867, p. 380. I have been unable to determine how successful this venture was.

4. Charles J. S. Warrington and Robert V. V. Nicholls, A History of Chemistry in Canada (Toronto: Sir Isaac Pitman and Sons, 1949), p. 38. [Hereinafter referred to as Warrington, Chemistry]. Warrington, Chemistry does not mention the Brockville venture.

and in March it had been announced that "Messrs. Wm. McMillan, of Bothwell, and George Macbeth, Wm. Bowman, and John Macbeth, of London" were applying for a charter for a company "to be called the Canada Chemical Manufacturing Company". The company was to engage in the "manufacturing of chemicals and dye stuffs" and had a nominal capital of $20,000 with $15,000 already subscribed.[1] Four months later, with the plant not yet completely finished, some 3,000 to 4,000 pounds of sulphuric acid were being produced daily with a daily output of 8,000 to 9,000 pounds per day expected by July. The gentlemen composing the company were identified as "Messrs. William McMillan, George McBett, late M.P.P., Hon. E. Leonard, M.L.C., who has been recently elevated to a life senator; W. Bowman, and Z. Smallman." The same article claimed that the customs returns showed that Canada West was using "upwards of $60,000" worth of sulphuric acid per year, all from the United States, and that the Canada Chemical Manufacturing Company would be able to supply all of the province's needs and still have a surplus to act as the starting point for the manufacture of other chemicals.[2]

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1. Canadian News, Mar. 21, 1867, p. 177.

2. Canadian News, July 18, 1867, p. 39.

Warrington and Nicholls do not identify the Canada Chemical Manufacturing Company by name but are clearly talking about the same company in their account. They give the impression that there were fewer people involved and fail to mention those who encouraged the manufacture of sulphuric acid or others who proposed to enter the business of manufacturing sulphuric acid. Regarding the "first" sulphuric "acid plant in Canada" Warrington and Nicholls write that

> the promoters of this venture were Williams Bowman and T. H. Smallman who were, respectively, ticket agent and superintendent of the London and Port Stanley Railway. It was over this line that carboys of acid were transported in 1866 after having been brought across Lake Erie by sailing vessel from Cleveland, their destination being the oil refineries of London and Petrolia ... The main outlets for the refined product were in heating and lighting, and Bowman and Smallman had noted that it was just in the autumn, when the refineries were at their busiest preparing for the winter's needs of "stove and lamp oil", that fate was unkind, and the sulphuric acid cargoes were often delayed or missing entirely. This apparent coincidence was often due to the fact that acid had to be carried as deck cargo, and when an autumnal gale arose, the crew, fearing the carboys would break, jettisoned them. The resulting uncertainty of delivery suggested to Bowman and Smallman the need for a local source of acid.1

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1. Warrington, Chemistry, p. 38. As far as I am able to determine, petroleum, contrary to Warrington, was used very infrequently for heating. Warrington, as with so much that he claims, never makes it clear where he is getting his information. On page 490 in his list of references for Chapter 2, Scott, B.J., "The Economic & History of London, Canada", (M.A. History Thesis, University of Western Ontario, 1930) is listed as a source. To begin with the title is listed incompletely; it should read The Economic and Industrial History of the City of London, Canada, From the Building of the First Railway, 1865, to the Present, 1930. I believe that this unpublished thesis is the source for much of his information. The Scott thesis which I have examined is virtually devoid of any documentation, a most incredible piece of literature.

With the completion of sulphuric acid production facilities in Canada all or almost all of the essential materials for a Canadian oil industry were being produced in Canada. The pride in this accomplishment is evident throughout articles such as Alexander Somerville's description of Waterman's new refinery in London. It is most evident in his summation of the "erection of these works.

> From the day when the first spadeful of earth was turned to the day when stills, engine, pump, and all accessories were in full operation, only seven weeks elapsed. The pump was made at Brooklyn, in the States; all the other work--stills, tanks, and construction, emanated from little London city, except the engine--that was made by Beckett and Sons, of Hamilton.[1]

It was a far cry from the chaos, confusion, and jerry-built work of a few years earlier. Occasionally refiners would come from outside bringing their equipment with them but it was not a necessity.[2]

The men who had successfully established an oil industry in Canada during the 1860s had faced and solved a great many problems. In the area immediately surrounding the oil fields there were no factories or major workshops

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1. Canadian News, Feb. 28, 1867, p. 132.

2. See for example, Observer, July 14, 1871, a reference to the Dominion of Canada Oil Refining Company.

in 1860 and transportation facilities were notoriously deficient. But if the industry were to survive as a viable economic and technological entity the oil men had to have constant and reliable sources of parts, materials, and equipment. Canadian entrepreneurs responded to the challenge. Repair shops and small manufactures were established in the oil fields. The growth of standardization meant that fewer varieties of parts were needed; at the same time, vertical integration of companies helped to minimize the number of weak and unreliable links in the processing and supply chains. Outside of the oil fields manufacturers of chemicals and heavy equipment, such as steam engines and boilers, were producing for the oil industry. The establishment of the sulphuric acid industry in Canada was a direct result of the oil boom as was the increase in steam engine production. Both required sophisticated equipment and skilled personnel. By the end of the decade it was clear that Canada, a new nation, possessed the requisite engineering skill and manufacturing capacity to develop, support and utilize the products of a major and highly specialized mining industry. The products and the skills associated with the petroleum industry were felt and would continue to be felt beyond the immediate confines of that one particular industry.

CONCLUSIONS

In a work that purports to be essentially descriptive and narrative it would be unwise and a misrepresentation to conclude with an interpretive essay. However, this is not to say that there is not a place for some rather general observations on the basic findings of the thesis.

During the period under consideration and despite great difficulty a new industry had been established on a foundation that was not entirely unsound. By the end of the 1860s there was little doubt that petroleum was a valuable commercial product. Petroleum was only beginning to be appreciated and subsequent decades and a new century were to reveal many more uses for petroleum; many of these had been thought of and to some extent sought after in the 1860s when their realization was still in the future. Although the pace of technological change is accelerating there are retarding forces associated with any change and the petroleum industry was no exception. Technological, financial, and psychological barriers chained petroleum to the illuminating industry. Petroleum made forays into various areas of utilization and established itself in minor ways as fuel, medicine, and lubricant but in terms

of immediate returns and value these endeavours were minor and peripheral. However, the lack of success in some areas should not overshadow the importance of petroleum in the 1860s or the great technical accomplishments that were the foundation of the industry.

The oil industry is a mining industry and future studies should be made comparing its growth with that of other more conventional mining industries. It is only recently that a level of scientific and technological sophistication has been reached that allows mineral finds to be made independent of surface indications. The early oilmen were attracted by surface shows which did not supply oil in commercial quantities. One of the earliest problems was simply that of getting oil out of the ground. After some attempts at roasting the oil soaked earth of the Gum Beds it was decided that the best way of getting oil was as a liquid from wells. The oilmen were simply trying to get a valuable liquid to the surface of the earth and wells were the best way to do this. Various types of wells, each with its own special characteristics and mode of construction, were tried until the most suitable was found.

The earliest wells were little more than big holes dug into the ground. These surface wells were dug with

pick and shovel and curbed with the wood available: logs, square timber or planks. The oil was expected to seep in through the bottom of the well and would be stored there until pumped out. Surface wells could not be made to penetrate bedrock which was where most of the oil was. The result was that wells were drilled with percussion drills. Since part of the well was drilled and serving purely as a conductor it made sense to drill all of the well. Augers went to bedrock and percussion drills beyond. The combination of auger and percussion drill was valued by the oilmen, men whose sole purpose was to get a valuable liquid out of the earth, simply because it was the fastest way of sinking wells.

In the quest for the best combination of low costs and high yield per well various sources of power were used to sink and pump oil wells. The simplest way was to have labourers kick or treadle them down, a sensible method when men were available and other power sources and equipment were not only scarce but also expensive. As the major means of sinking and pumping wells kicking was replaced by more complicated but faster and less burdensome horsepower rigs and steam engines.

The introduction and regular use of steam engines

is a symbol of the increased technological sophistication of the oil industry in Lambton county and of the general response of Canada to the oil industry. A great variety of machinery and supplies were needed and by the end of the 1860s they could be produced in Canada and maintained, even if not produced in Lambton county.

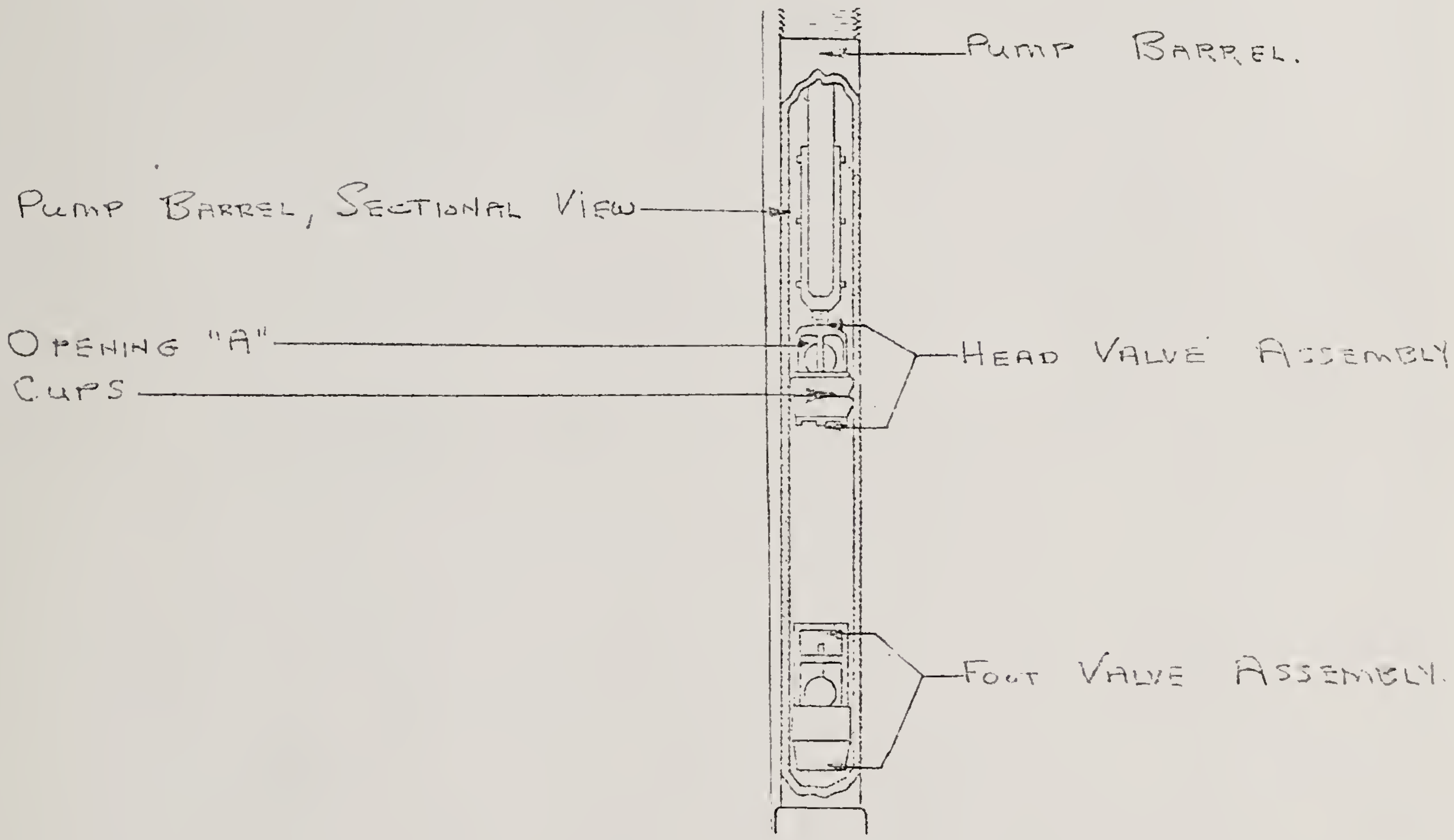
The urgent need for innovative thinking which characterizes a new and/or rapidly changing technology is seen in an examination of one of the most critical problems faced by the oil industry in the 1860s: the storage of petroleum. The barrels first used were not suitable because, no matter how well made, the oil would permeate the wood and leak out. Barrels were produced which were coated with and impregnated by materials which were not oil soluble. Impregnated barrels did not satisfy all storage needs because they were small, expensive, and could not be economically produced to meet the wildly fluctuating demands of the oil industry. Underground tanks and above ground iron tanks gave greater storage capacity. By the late 1860s there were a number of means available for storing oil, either while stationary or being moved, and these met the needs of the industry at the time.

Special problems arose not only because petroleum was a liquid but also because it was a very malodorous liquid. Most crude petroleum is rather nauseating and vile smelling. Lambton county petroleum had a particularly bad odour and was therefore even more in need of deodorization than say Pennsylvania petroleum. Crude petroleum needs treating because it is a mixture of many compounds which when separated into groups are valuable but until then are of very limited use and value. The refining of petroleum to produce a marketable illuminant was the major problem plaguing the oil industry throughout the 1860s. The chemical knowledge of the day would not allow the offensive chemical compounds to be identified but methods of removal were empirically developed, primarily outside of Canada, until the work of Frasch in the 1870s. It was not until the late 1860s that Canadian refined illuminants came up to international standards because prior to that the Canadian refiners had not given the crude the time and care, and therefore the money, that it needed. Whether or not this lack of care was characteristic of other Canadian industries at the time is a point that should be pursued.

For much of the decade 1860-70 it was possible to pass off inferior products on a public which was just learning to live with and assess petroleum. For much of that same decade there was some doubt as to whether the highly publicized oil industry was just another bubble, just another Yankee swindle, or whether it was a new part of the industrial world. By the end of the decade it was clear that although there had been a number of frauds in the industry the idea of a petroleum industry was a legitimate one. By 1870 a new and struggling but viable industry had been created in Canada. However, it was more than an industry; it was an important formative influence in the development of a young country.

Figure I

DEEP WELL PUMP



Based on Arthur M. Greene, Jr., Pumping Machinery: A Treatise on the History, Design, Construction and Operation of Various Forms of Pumps (2nd ed.; New York: John Wiley & Sons, 1919), p. 279. Courtesy Metropolitan Toronto Library Board.

PLATE I. Lick Well, Albert Farm, Bothwell, circa 1866.
Courtesy Ontario Department of Mines.

PLATE II. Pepper Oil Well, Bothwell, circa 1866.
Courtesy Ontario Department of Mines.

PLATE III. Spring pole drilling rig. Courtesy Ontario Department of Mines.

PLATE IV. Victoria Well, Bothwell Ontario, circa 1866. Courtesy Ontario Department of Mines.

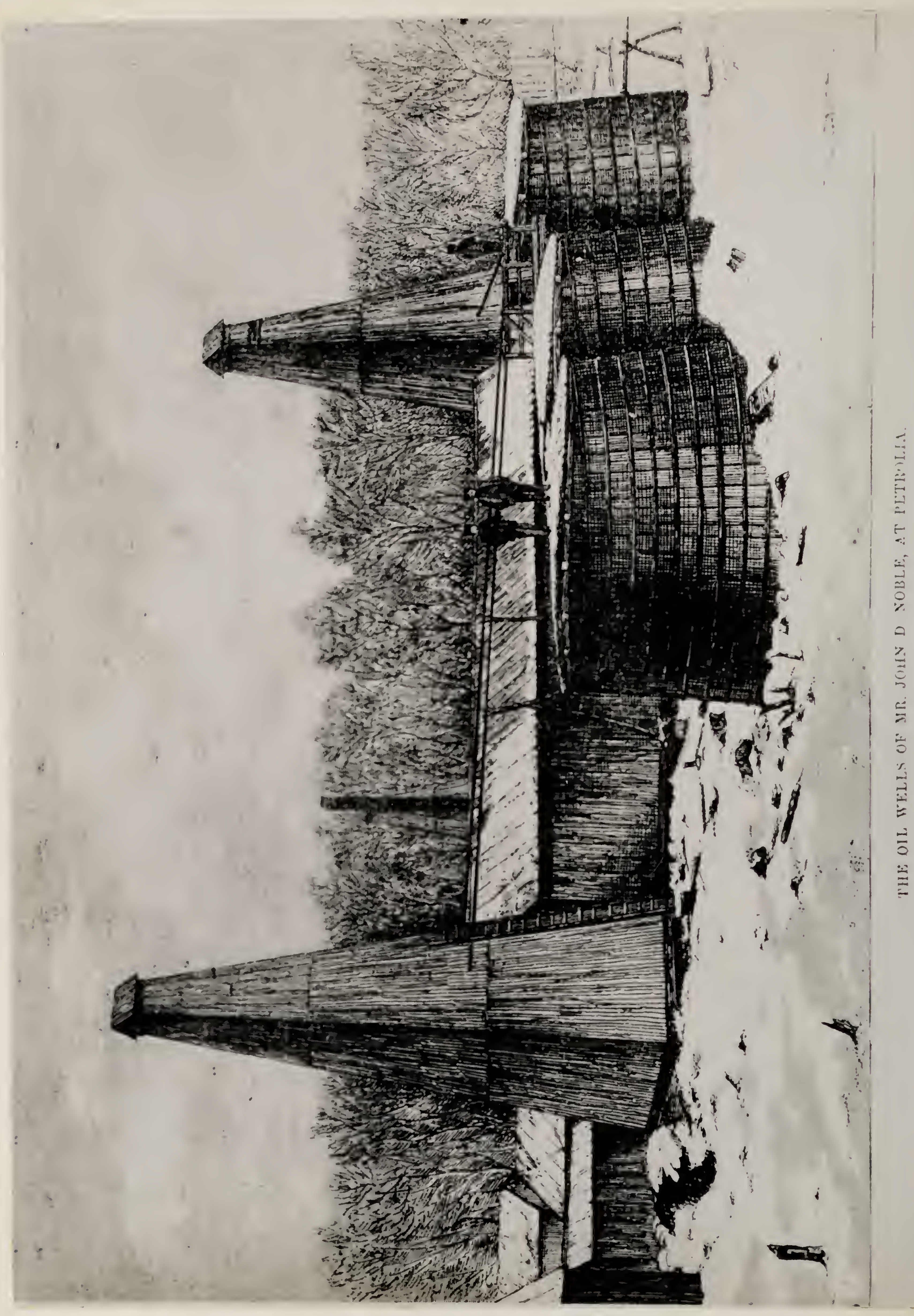
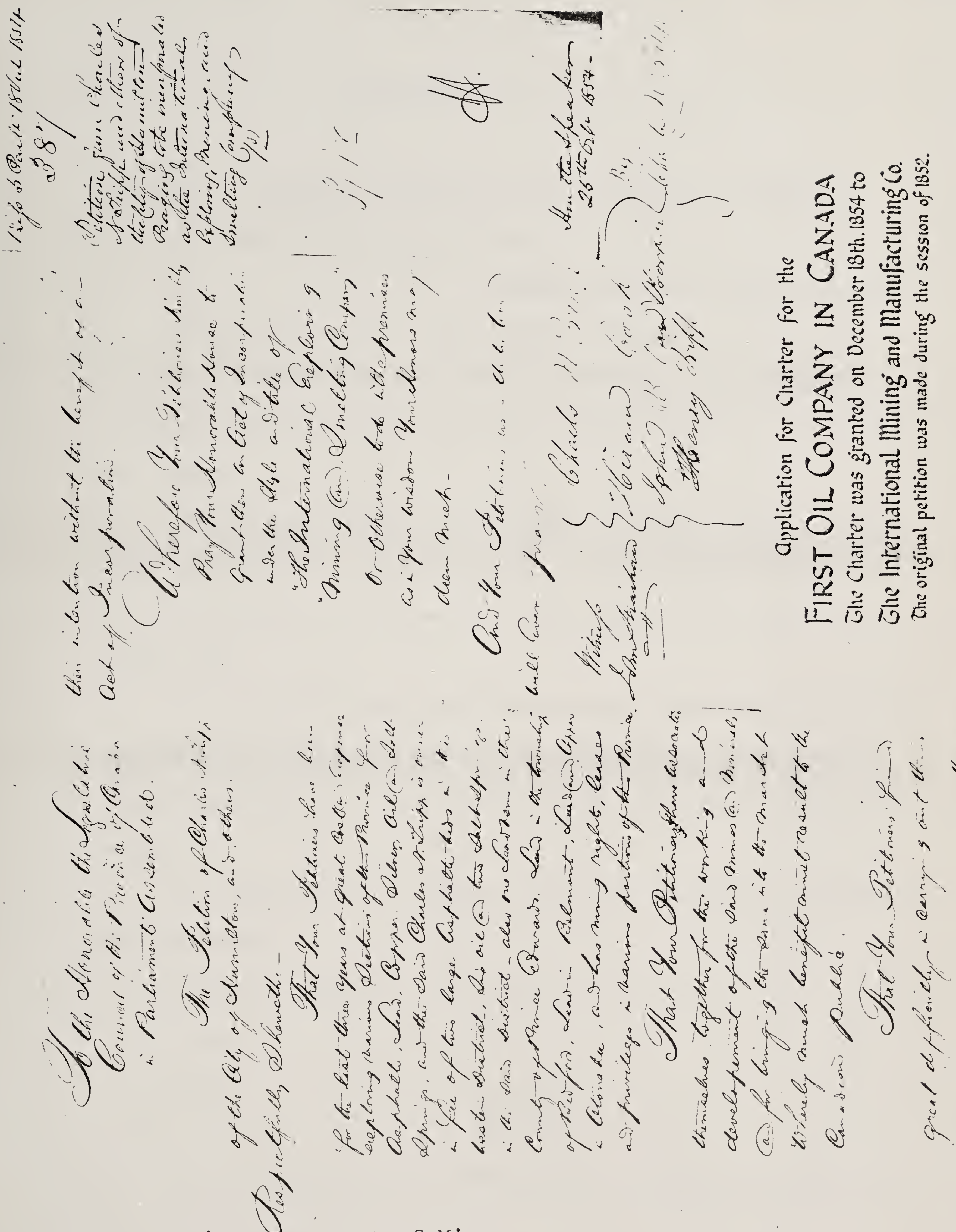


PLATE V. From Canadian Illustrated News, III (February 11, 1871), 84. Courtesy Metropolitan Toronto Library Board.

PLATE VI. Map from James David Edgar, A Manual For Oil Men and Dealers in Land (Toronto: Rollo & Adams, 1866), frontispiece. Courtesy Metropolitan Toronto Library Board.

APPENDIX A


To the Honorable the Legislative Council of the Province of Canada in Parliament Assembled.

The Petition of Charles N. Tripp of the City of Hamilton, and others.

Respectfully Sheweth. –

That Your Petitioners have been for the last three years at great cost and expense exploring various Sections of this Province for Asphalte, Lead, Copper, Silver, Oil and Salt Springs, and the said Charles N. Tripp is owner in fee of two large Asphalte beds in the Western District, [illegible] oil and two Salt Springs in the said District – also one Lead [illegible] in the County of Prince Edwards. Lead in the township of Bedford, Lead in Belmont, Lead and Copper in Olonabee, and has mining rights, leases and privileges in various portions of this Province.

That Your Petitioners have associated themselves together for the working and developement of the said mines and minerals and for bringing the same into the market whereby much benefit must result to the Canadian public.

That Your Petitioners find great difficulty in carrying out their intention without the benefit of an Act of Incorporation.

Wherefore Your Petitioners humbly Pray Your Honorable House to Grant them an Act of Incorporation under the Style and title of "The International Exploring Mining and Smelting Company" Or Otherwise to do in the premises as in Your wisdom Your Honors may deem meet. –

And Your Petitioners as in duty bound will ever pray.

Witness John Strachan

Charles N. Tripp
Hiram Cook
John B. [illegible]
Henry Tripp

Recd & Read 18 Oct 1854
387
Petition from Charles N. Tripp and others of the City of Hamilton Praying to be incorporated as the International Exploring, Mining, and Smelting Company

Hon the Speaker
25th Oct 1854 –
By [illegible]

Application for Charter for the

FIRST OIL COMPANY IN CANADA

The Charter was granted on December 18th, 1854 to

The International Mining and Manufacturing Co.

The original petition was made during the session of 1852.

Courtesy Ontario Department of Mines.

APPENDIX B

Report of Chemical Examination on a Sample of Asphalt Sent Forward to Me by Mr. Tripp

Signed: Thos. D. Antisell, M.D.

This asphalt is a semi-solid substance, soft, and plastic in the fingers, blackish color in the interior, fracture tenacious and stringy without lustre ... adheres to paper.

The outer portion of the mass is mixed with undecomposed woody fibre, and rootlets. From these the interior is quite free, and it was on this matter that experiments were made.

The specific gravity of the sample is 1.014. It does not yield anything to cold water, but by boiling water a minute portion of volatile liquid is diffused through the water.

On examination in closed and open crucibles it yielded in 100 parts.--

Volatile matter	80.06
Coke	13.57
Ash	6.37
	100.00

On distillation at temperatures of boiling water, it

yielded a moderate amount of liquid resembling Benzoles. The application of a higher heat drove off additional volatile liquids, and a considerable quantity of paraffine. From the experiments I made, I am inclined to believe that the crude material, if properly worked, would yield nearly 15 per cent of naphtha-liquid. This mineral is partly soluble in alcohol, a yellow resin being dissolved out by that fluid. It is completely soluble in naphtha, ether, and oil of turpentine.

The earthy matters are the only residue in the three latter liquids. It melts at 212°, swelling up and softening from 180° onwards -- softened in water, it gives off copious bubbles of air.

I look on this as a valuable variety of bitumen and applicable to all purposes for which this substance is now in demand. Its softness and fusibility renders it valuable in the manufacture of Japan and other varnishes. It is peculiarly fitted for obtaining from it, by distillation, the Naphtha-liquid, (Benzole) which are now so extensively used as a solvent for Gutta-Percha, and other gums and resins. For this branch of manufacture, this variety of bitumen appears more adapted than the solid and lustrous asphalt.

For the fabrication of mastics and cements, it is

also well adapted, being capable of intimate mixture with the other materials at a low temperature, it makes a good hydraulic cement.

This bitumen is admirably adapted for illuminating purposes in either of two ways. First, by the use of benzole liquids obtained from it by distillation, these might be used when diluted with alcohol or other menstrums, as the burning fluid in this is used or second, as offering an illuminating gas. By reference to the analysis it appears that 80 per cent is capable of being converted into combustible gases. These gases would be highly charged with carbon, would yield a brilliant light, and require less purification than the gases derived from coal. In equal weight, this bitumen would yield a greater amount of illuminating gases than the finest variety of bituminous coal.

For the manufacture of gases, this bitumen requires a peculiar variety of furnaces and retorts.

This bitumen is adapted for use in all the purposes in which the mineral may be used, but the manufacture of volatile liquids and of illuminating gases appears to be its most appropriate uses.

(signed) Thomas Antisell, M.D.
Consulting and Analytical Chemist
No. 63 Franklin St., New York

The above is as it appears in _Canadian Oil Leaders,_ an unpublished MSS. of the late Col. R. B. Harkness of Port Rowan, Ontario. Surviving portions of the manuscript are in the possession of Mr. W. D. Brittain, Chief Inspector, Petroleum Resources, Department of Mines and Northern Affairs (Ontario).

APPENDIX C

Gas Company's Office
Hamilton, February 7th, 1855.

Chas. Tripp, Esq.,

Dear Sir:

At your request I beg to send you the result of your experiment with the asphalt you sent us.

The quantity weighed before using was 1,450 pounds. This was put into 16 retorts, and sealed up in the usual way -- in three hours it had given off 4,600 cubic feet of gas, which I put into an empty holder, and used it in the early part of the night. It burns with a very soft pure light, without smell. I should say that so far as illuminating power goes, it is 10 to 15 per cent over the ordinary coal gas.

The amount of residual deposited I have no means of ascertaining, as it became mixed with the tar and ammonia residue in the retorts, I believe the specimen I used was of inferior quality on account of being taken off the surface and containing a considerable quantity of earthy and vegetable matter.

I am, Sir,

Yours most respectfully,

(signed) Thos. McIlwraith,
Manager, Gas Company

The source of the above is the same as for Appendix B. Both were copied as given in the MSS. without correction.

APPENDIX D

Testifying before a Royal Commission Martin Woodward, a Petrolia well owner, described the pumping of wells:

> The average daily supply from a well is five to ten barrels of water and oil mixed, but of oil they average something less than a barrel a day. I have known as many as ninety wells to be pumped by the one engine. In most cases they use a bricked-in boiler. The drive wheel is connected with a wheel which has a pitman on each side that works a horizontal wheel backwards and forwards. The jerker rods are attached on opposite sides of the wheel and connect with the pump over the hole. Iron rods are used in the pump, their weight being sufficient to make it drop. As far as I know the jerker was first used here; I never heard of it anywhere else before. It was used here before it was used in the States. I cannot tell you the number of wells that are being worked in this territory, but I think there are about 2,500.[1]

Of the same system Robert Bell wrote that in

> the early days of the industry a separate engine was used to pump each well, but now, by an ingenious contrivance of rods and cranks, called "jerkers," 20 to 40, and even 50 wells, are pumped by one engine, and this of much smaller power than would be supposed necessary. In one case, Mr. Englehart worked no fewer than 70 wells with a single engine by this means. The rods, which are small, are made of hard wood, spliced together with iron, and, in order to diminish friction, they are hung from a horizontal wooden rail about four feet from the ground, by means of very light iron suspenders, which swing backward and forward with each stroke of the engine. The direction of the force is changed, whenever required, by means of horizontal

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1. Report of the Royal Commission on the Mineral Resources of Ontario and Measures for Their Development (Toronto: Warwick & Sons, 1890), p. 157. [Hereinafter referred to as Commission on Minerals of Ontario.]

> cranks. With such economy in the cost of pumping, it has become possible to work profitably wells which yield only small quantities of oil. Indeed, in 1886, the average production per well per day in the Petrolia region was only twenty-three imperial gallons, or not much more than half-a-barrel. The ten larges wells in the district furnished an average of twenty barrels each, of thirty-five imperial gallons, per day.1

The horizontal cranks that Bell refers to could possibly be bell cranks although I would expect to find field wheels instead. Field wheels are horizontal wheels from which jerker rods radiate in pairs parallel to each other.

J. H. Fairbank claimed that he originated the system of multiple pumping but I have shown in the body of the thesis that this is not so. The important thing to note is that he did not claim the introduction of the field wheel. Local tradition in the oil fields insists that he did and many that I have talked to say that he claimed such in his testimony before the Royal Commission. Fairbank made no such claim.

> The system of working a number of wells from the one engine, the jerker system, came in as the production fell off. When we had large wells we would abandon a well that produced only five or six barrels a day; now the man who gets a well of that kind is considered to strike it rich. The jerker system was adopted about twenty-five years ago. I remember the time the first jerker was put into operation. It was not patented, and I do not

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1. Robert Bell, "The Petroleum Field of Ontario," Proceedings and Transactions of the Royal Society of Canada, V (1887), 111.

> know that it could be. I had a well too hard to work by man power; I hadn't an engine, but there was engine power within reach and I applied the present jerker system. I think that was in 1863. The majority of wells were then worked by man power with a spring pole. The jerker is universal now, and it would be impossible to work upon the old system. It was first used with a horizontal walking beam, that was afterwatds improved by using the wheel, with which there is a great deal less friction. I think Mr. Reynolds was the first who introduced the wheel; he is still here. With one engine now they work from half a dozen to eighty or ninety wells, with one boiler but often two engines.1

Mr. Reynolds was not called upon to testify. I do not know the date at which the field wheel was introduced.

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1. Commission on Minerals of Ontario, p. 159.

BIBLIOGRAPHIC ESSAY

Manuscript, Unpublished and Private Collections

Two private collections and their owners, George Smith and Ed Phelps, provided invaluable material and assistance.

The Smith Collection is owned by George Smith an antique and antiquarian book dealer in Sarnia and Brights Grove, Ontario. Part of the Smith Collection is composed of books and pamphlets dealing with Ontario history in general and Lambton county in particular. Much of the Lambton county material is composed of newspaper clippings collected by George Smith and his father the late Leslie Smith. Leslie Smith searched Sarnia newspapers for items of interest to Lambton county historians. He worked with originals and microfilms; items from the former became part of his clipping files. Notes made from microfilm were grouped under various subject headings. The clippings and notes of the late Leslie Smith were made available to me by his son George and Xerox copies of much of this material are in my possession.

The collection of Ed Phelps comprises published and manuscript material. Much of his material has been donated to the library of which he is librarian: the

Regional History Library at the University of Western Ontario. The two collections should be dealt with as a unit; together they contain personal and legal papers, histories, directories and gazetteers as well as maps and photographic material. Most of the personal papers postdate the period under study but through Mr. Phelps I was able to obtain a Xerox copy of the Diary of J. H. Fairbank for the years 1862-64. Entries in the diary are not daily but those present provide considerable insight into early oil work.

One of the holdings of the library of the University of Western Ontario is the Barnett Engineering Collection, normally referred to as the Barnett Bundles. The collection is composed of several hundred roughly indexed manila envelopes of clippings from mid to late nineteenth century technical journals. Each envelope contains items on a different topic one of which is petroleum. Most of the material is post 1870 but the collection is the source of much valuable information on the utilization of petroleum.

Only one of the collections consulted was exclusively manuscript, viz. that of the late Col. Bruce Harkness, former Oil and Gas Commissioner for the

Province of Ontario. Col. Harkness had planned to write a history of oil and gas in Ontario but the project was not completed before his death. His material is in the possession of his widow and the Department of Mines and Northern Affairs for the Province of Ontario. Thanks to the kindness of Mrs. Harkness and Mr. William Brittain of the Department of Mines and Northern Affairs I was given full access to his manuscripts which are now in my files in Xerox copy. The Harkness material is a good guide to major developments but interesting as it is, it is of rather limited value because it is almost completely undocumented.

Periodical Literature

Periodical literature provided most of the information for this thesis. The paucity of Canadian non-agricultural technical journals during the 1860s made it necessary to rely heavily on newspapers. Newspapers are an invaluable primary source but studying them is very time consuming and a complete study of all Ontario or Canadian newspapers for the 1860s was not possible. A number of newspapers were examined before picking several for very detailed study. Paradoxical as it may seem the best surviving newspaper for coverage of the

oil industry in Canada was not Canadian but British: the Canadian News. The Canadian News was devoted solely to news of and pertaining to the British North American possessions. The Canadian News avoided partisan political commentary and concentrated on issues of interest to investors, businessmen and emmigrants. By using this paper the views of a considerable number of Canadian newspapers were received because it was largely a collection of articles and news items taken, with and without credit, from Canadian newspapers. These borrowed articles were supplemented by the work of special correspondents.

The Sarnia Observer was the other newspaper consulted frequently and in doing this the notes of the late Leslie Smith were very useful. Other papers were searched for select periods of intense activity or excitement when as many views and reports as possible were needed. The most complete list of Canadian newspapers on microfilm and the location of the originals is the Canadian Newspapers on Microfilm Catalogue(151 Sparks Street, Ottawa: Canadian Library Association, 1959) which is a looseleaf accumulative publication updated annually.

Although newspapers were the main form of periodical literature used various journals were also examined.

Only journals found to be useful will be mentioned. During the 1860s the only Canadian technical journal which was not primarily agricultural was the _Journal of the Board of Arts and Manufactures for Upper Canada._

It started in January 1861 and ran on a monthly basis until the last issue in February of 1868. The journal was produced on a very limited budget and consisted mainly of articles from the journals and newspapers of Britain, Europe and the United States. Considerable Canadian material was also printed and because the oil industry was one of the most exciting and promising Canadian industries during the life of the _Journal of the Board of Arts and Manufactures for Upper Canada_ it was the subject of many articles and news items. The journal is well-indexed and material from other sources was acknowledged.

The Canadian Journal of Industry, Science, and Art was published by the Canadian Institute, now the Royal Canadian Institute. The main emphasis is not on technology and engineering but the oil industry was the subject of some papers in this journal.

The other journals of major use were not of Canadian origin. No journals were found which made a sustained effort to follow and/or analyse the oil

industry in Canada but most of the engineering journals mentioned petroleum in Canada irregularly. The journals studied which fit into this category are The Artizan, Chemical News, Engineering, Journal of the Royal Society of Arts, and Transactions of the British Association for the Advancement of Science. All of these journals are well-indexed.

Background and other published material

One of the major problems facing historians of technology and resource utilization is the difficulty of finding reputable works to supply relevant background material. Historians of petroleum are verv fortunate in this respect because Professor R. J. Forbes has turned his attention to petroleum in three separate works. Combined, the three works provide a relatively detailed study of petroleum from prehistory to the nineteenth century. The smallest of these three works, R. J. Forbes, Studies in Ancient Technology, Vol. I (Leiden: E. J. Brill, 1964) has the first 124 pages devoted to bitumen and petroleum in antiquity. R. J. Forbes, Studies in Early Petroleum History (Leiden: E. J. Brill, 1958) and R. J. Forbes, More Studies in Early Petroleum History (Leiden: E. J. Brill, 1959) bring his petroleum studies to the

late nineteenth century. Forbes' work is very carefully written, well-documented and and covers a wide range of uses and processes.

The most comprehensive history of the petroleum industry in the United States is a two volume work primarily by Professors Williamson and Daum: Harold F. Williamson and Arnold R. Daum, The American Petroleum Industry, Vol. I: The Age of Illumination 1859-1899 (Evanston: Northwestern University Press, 1959) and Harold F. Williamson, Arnold R. Daum, et al., The American Petroleum Industry, Vol. II: The Age of Energy 1899-1959 (Evanston: Northwestern University Press, 1963). The work of Professors Williamson and Daum is likely to remain the standard and most comprehensive work on the oil industry in the United States for many years to come. Williamson and Daum have confined their work exclusively to the United States. Their perspective is that of the economic historian and although they do introduce technical matters their treatment of them is of rather limited depth.

The work of Williamson and Daum combined with that of Forbes provides an excellent introduction to the main currents in the history of petroleum. Very little

information pertaining to nineteenth century Canada is supplied by either Williamson and Daum or Forbes but one is made aware of problems, developments and uses in other countries and is in this way prepared to study what happened in Canada.

Material has been published dealing with the development of the petroleum industry in Canada but in terms of quality and completeness none of it approaches the work of Forbes or Williamson and Daum. The most frequently quoted is Victor Ross, Petroleum in Canada (Toronto: Southam Press, 1917), a pleasant but undocumented and vague book. Ross set out to tell the story of the petroleum industry in Canada in a popular style. He has neither footnotes nor bibliography and rarely uses dates with the result that one cannot follow up or check his statements. In some cases it is not always possible to tell what decade Ross is dealing with. Ross has given a general outline and little more.

Local histories are often overlooked because they lack the usual scholarly paraphernalia of footnotes and bibliography and are sometimes notoriously unreliable: gifts laid at the feet of departed ancestors and founding fathers who could do no wrong. Three local histories

were useful in writing this thesis. Charles Whipp and Edward Phelps, Petrolia: 1866-1966 (Petrolia, Ontario: The Petrolia Advertiser-Topic and the Petrolia Centennial Committee, 1966) is the result of the combined efforts of a librarian-scholar, Mr. Phelps, and a newspaper owner-editor, Mr. Whipp. The book was written primarily for local consumption but should be read by all interested in Ontario or petroleum history. There are two modern histories of Lambton county: Jean Turnbull Elford, A History of Lambton County (Sarnia: Lambton Historical Society, 1967) and Victor Lauriston, Lambton's Hundred Years: 1849-1949 (Sarnia: Haines Frontier Printing Company, n.d.). Lauriston's work is out of print. Until recently the value of this book to scholars was marred by the lack of an index, but George Smith has prepared a very complete index. George Smith, Index to Victor Lauriston's Lambton's One Hundred Years: 1849-1949 (Wyoming, Ontario: Lambton County Library, 1971).

The best summary of early oil development in Ontario is Edward Phelps, "Foundations of the Canadian Oil Industry, 1850-1866," Profiles of a Province: Studies in the History of Ontario (Toronto: Ontario Historical Society, 1967), pp. 156-164.

During the late nineteenth century one of the leading authorities on petroleum was Sir Boverton Redwood. A familiarity with at least parts of Boverton Redwood, Petroleum - A Treatise (2 vols.; London: Griffin, 1896) is essential for anyone interested in the history of petroleum in the nineteenth century.

The major nineteenth century use of petroleum was as an illuminant. The search for illuminants and the use of hydrocarbons immediately prior to the oil boom is summarised, complete with patent references, in Thomas Antisell, The Manufacture of Photogenic or Hydro-Carbon Oils from Coal and Other Bituminous Substances Capable of Supplying Burning Fluids (New York: D. Appleton and Co., 1859). A history of the development of lighting in Canada is Loris Russell, A Heritage of Light: Lamps and Lighting in the Early Canadian Home (Toronto: University of Toronto Press, 1968). Professor Russell's work is carefully written and research and well-documented.

During the 1860s very few serious books were published on the subject of petroleum but there were some. The best early work on petroleum is A. Norman Tate, Petroleum and Its Products: An Account of the History, Origin, Composition, Properties, Uses, and Commercial Value, &c., of Petroleum, The Methods Employed in Refining

it, and the Properties, Uses, &c., of its Products (London: John W. Dawes, 1863). Tate was an analytical chemist from Liverpool with a long involvement with petroleum and other hydrocarbon oils. His work is largely on English practice but is an excellent source of information on all that the lengthy title promised plus a discussion of the opposition to the introduction of petroleum.

Much of the promotional literature associated with the petroleum industry in the 1860s was filled with little more than optimistic promises. However, one gave more; a publication of the Canadian Native Oil Company, (Limited), The Canadian Native Oil: Its Story, Its Uses, and Its Profits, With Some Account of A Visit to the Oil Wells (London: Ashby & Co., 1862) provided descriptions of drilling, pumping, and refining as well as much on the problems plaguing the oil fields.

Various other works provided small amounts of information, mainly peripheral and/or a repetition of that to be found in the sources discussed. Duplicate sources have been listed and discussed in footnotes.